THE PLANT DISEASE REPORTER

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Division of Mycology and Disease Survey

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The Plant Disease Reporter is issued as a service to plant pathologists throughout the United States. It contains reports, summaries, observations, and comments submitted voluntarily by qualified observers. These reports often are in the form of suggestions, queries, and opinions, frequently purely tentative, offered for consideration or discussion rather than as matters of established fact. In accepting and publishing this material the Division of Mycology and Disease Survey serves merely as an informational clearing house. It does not assume responsibility for the subject matter.

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DIVISION OF MYCOLOGY AND DISEASE SURVEY

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SEED TREATMENT WITH NEW AS COMPARED WITH OLDER FUNGICIDES FOR THE CONTROL OF WHEAT, OAT AND SORGHUM SMUT AND VICTORIA BLIGHT OF OATS IN KANSAS, 1950 TO 1952[1]

E. D. Hansing[2]

Experiments were conducted in the field nursery in 1950, 1951, and 1952 comparing new fungicides with older ones to determine their relative value as seed treatments for the control of bunt or stinking smut of wheat, loose and covered smuts of oats, covered kernel smut of sorghum, and Victoria blight of oats (Hansing 1, 2, 3). Experiments were conducted also in the nursery to determine the comparative effect of these fungicides on emergence of these crops.

Materials and Methods

The following fungicides were tested:

Panogen -- 2.1% methyl mercury dicyan diamide (1.4% Hg) is produced by Panogen Inc., New York. It was used for the experiments conducted in 1950 and during the spring of 1951. Panogen 2.2% methyl mercury dicyan diamide (1.5% Hg) was used in the fall of 1951 and during 1952. Additional formulations of Panogen with 1.7%, 2.0%, and 2.3% mercury were tested for the control of wheat bunt, and 1.7%, 2.0%, 2.3%, and 2.5% mercury were tested for control of oat smuts. Panogen is a volatile organic mercury in solution in a water-miscible carrier. It was applied full strength and in addition, for the control of oat smut in 1952, it was diluted 1 to 4 and 1 to 9 with water, The former dilution was used also for control of sorghum smut in 1952.

Ceresan M -- 7.7% ethyl mercury p-toluene sulfonanilide (3.2% Hg), is produced by E. I. du Pont de Nemours and Company, Wilmington, Delaware, and was applied as a slurry. It was used as a standard of comparison for volatile organic mercury fungicides.

New Improved Ceresan -- 5% ethyl mercury phosphate (3.8% Hg), another du Pont product, was applied as a dust. It was used as a second standard of comparison for volatile organic mercury fungicides.

Agrox -- 6.7% phenyl mercury urea (4% Hg), is distributed by Chipman Chemical Company, Bound Brook, New Jersey, and was applied as a slurry.

Setrete -- 7% phenyl mercuric ammonium acetate (4% Hg), is produced by W. A. Cleary Corp., New Brunswick, New Jersey, and was applied as 1 1/2 parts of Setrete to 8 parts of water. It contains the volatile organic mercury in a water solution.

Vancide 51 -- 30% sodium salts of dimethyl dihiocarbamic acid and 2-mercaptobenzothiazole is a nonvolatile liquid, produced by R. T. Vanderbilt Co., Inc., New York. It was applied full strength and in some experiments it was diluted 1 to 1 and 1 to 3 with water.

Arasan -- 50% thiram (tetramethylthiuram disulfide), another du Pont product, was applied as a dust. It was used as a standard of comparison for nonvolatile, nonmercury fungicides.

Arasan SF-X -- 75% thiram, a nondusty formulation, was applied as a dust and also as a slurry in the 1952 sorghum experiments.

Spergon -- 96% chloranil (tetrachloro-para-benzoquinone), produced by United States Rubber Company, Naugatuck, Connecticut, was used as a dust. It was used also as a standard of comparison for nonvolatile, nonmercury fungicides.

Copper carbonate -- 50% metallic copper, was included in the experiments on the control of bunt because it is still used commercially to some extent.

The methods of inoculation were as follows:

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Wheat Bunt -- Red Chief wheat was inoculated artificially with chlamydospores of Tilletia foetida at the rate of 1 part inoculum to 100 parts of seed by volume. For the experiment in 1952 MoKing wheat also was included.

Oat Smut -- Kanota oat seed was inoculated artificially by the partial evacuation method with a water suspension of chlamydospores of Ustilago avenae and U. kolleri at the rate of 1 part of inoculum to 100 parts of seed by volume. After the seed was inoculated it was spread out to dry thoroughly before it was treated.

Covered Kernel Smut Of Sorghum -- Red kafir seed was inoculated artificially with chlamydospores of Sphacelotheca sorghi at the rate of 1 percent of spores by volume.

Victoria Blight -- Osage oat seed was inoculated artificially by the partial evacuation method with a suspension of chlamydospores and mycelium of Helminthosporium victoriae at the rate of five Petri dish cultures per liter of seed. After the seed was inoculated it was spread out to dry thoroughly before it was treated.

The seed was treated by the following method: One liter of inoculated seed was placed in a gallon glass jar. The liquid and slurry fungicides were applied with a pipette to the inside of the jar and then mixed with the seed by rapid rotation of the jar. The dust fungicides were added to the seed and similarly mixed until the seed was thoroughly coated. By this method it was possible to distribute the fungicide on the seed at least as well as that obtained with commercial liquid, slurry, and dust treaters. After the seed was treated it was stored in double 5-pound sacks with the top folded down.

The slurry treatments were applied at the rate of 4 and 8 cc per liter for the 1/2 and 1 ounce per bushel treatments, respectively; and with double the concentration at 8 and 16 cc per liter for the 2 and 4 ounces per bushel treatments, respectively.

The experiments for control of bunt were planted in November, and for smut and Victoria blight of oats in April, under conditions highly favorable for infection. The sorghum was planted in June when the soil temperatures were too high for maximum infection by kernel smut.

For each experiment on emergence, the seed was mixed thoroughly, treated in liter lots by the above method, and then stored in double 5-pound paper sacks folded down at the top. The first planting was made from two to four weeks after treating.

Certified seed of Pawnee and Comanche wheat was used. In 1950 plantings were made in October, November, and December while in 1951 plantings were made only in November and December.

For the experiments on oats, certified seed of Cherokee, Nemaha, and Osage (two lots) was used in 1950, and Nemaha and Neosho were used in 1951. One planting was made in February and one in March.

For the experiments on sorghum, certified seed of Combine and Midland was used. Plantings were made in May of 1950, 1951, and 1952 and in June of 1950 and 1951.

Emergence counts were made for each experiment when 50 percent of the plants had reached the second-leaf stage of development.

After the last planting was made the sacks of seed were stored in galvanized iron boxes with a different box for seed treated with each fungicide. A few naphthalene balls were placed in each box to keep out insects. Another planting of wheat was made one year after treating and sorghum plantings were made one and two years after treating.

All experiments on emergence were planted in five randomized replications with 200 seeds in each 12-foot row.

Experimental Results

Wheat Bunt -- Highly satisfactory bunt infection was obtained from untreated seed for all dates of planting with 57 to 95 percent occurring in 1951 and from 93 to 96 percent in 1952 (Table 1).

For the volatile mercury fungicides, Panogen, Ceresan M, New Improved Ceresan, and Agrox, with longer storage period and greater treatment rate, there was a corresponding decrease in the incidence of bunt. An increase in the concentration of Panogen also caused a corresponding decrease in the incidence of bunt.

Seed treated with Panogen 1.4 at 3/4 ounce, Ceresan M at 1/2 ounce, New Improved Ceresan at 1/2 ounce and Agrox at 1/2 ounce, the recommended rates per bushel, produced plants with 1 percent bunt or less after storage periods of 1, 1, 0, and 4 days, respectively, indicating that a longer storage period was necessary for Agrox than for the other fungicides.

Results from seed treated with the nonvolatile fungicides, Vancide 51, Arasan, Spergon,

Table 1. Effect of seed treatment with new as compared with older fungicides on the control of bunt in Red Chief and MoKing wheat, Manhattan, Kansas, 1951 and 1952[a].

Seed treatment			Days planted after treating											
			0[b]		1		2		4		8		16	
Fungicide	Form	Rate per bushel	1951	1952	1951	1952	1951	1952	1951	1952	1951	1952	1951	1952
		oz.	Percentage bunted heads											
No treatment	------	------	94	94	91	94	92	95	95	94	92	96	57	93
Panogen 1.4[c]	Liquid	1/2	4	5	1	2	T[d]	2	0	2	T	1	0	1
"	"	3/4	1	2	T	T	0	T	0	0	0	0	0	T
"	"	1	0	T	T	T	0	0	0	0	0	0	0	0
"	"	1 1/4	0	T	0	0	0	0	0	0	0	0	0	T
"	"	1 1/2	0	T	0	T	0	0	0	0	0	0	0	0
Panogen 1.7	Liquid	1/2	5	6	1	2	0	T	T	1	T	T	0	T
"	"	3/4	T	1	T	T	0	T	0	0	0	T	0	0
"	"	1	0	T	0	T	0	T	0	T	0	0	0	0
"	"	1 1/4	0	0	0	T	0	0	0	0	0	0	0	0
"	"	1 1/2	0	0	0	0	0	0	0	0	0	0	0	0
Panogen 2.0	Liquid	1/2	2	4	T	1	T	T	T	0	0	0	0	T
"	"	3/4	0	1	0	0	0	0	0	0	0	0	0	0
"	"	1	0	0	0	0	0	T	0	0	0	0	0	0
"	"	1 1/4	0	0	0	0	0	0	0	0	0	0	0	0
"	"	1 1/2	0	T	0	0	0	0	0	0	0	0	0	0
Panogen 2.3	Liquid	1/2	2	1	T	T	T	1	0	T	T	0	0	T
"	"	3/4	T	0	0	T	0	T	0	0	0	0	0	0
"	"	1	0	T	0	0	0	0	0	0	0	0	0	0
"	"	1 1/4	0	0	0	0	0	0	0	0	0	0	0	0
"	"	1 1/2	0	0	0	0	0	0	0	0	0	0	0	0
Ceresan M	Slurry	1/2	1	2	T	1	0	T	0	T	0	1	0	1
"	"	1	T	0	T	T	0	T	0	0	0	0	0	T
N. I. Ceresan	Dust	1/2	1	1	T	T	0	T	0	0	0	T	0	T
"	"	1	T	0	0	0	0	0	0	0	0	0	0	0
Agrox	Slurry	1/2	--	4	--	2	--	2	--	T	--	T	--	T
"	"	1	--	1	--	0	--	T	--	T	--	0	--	T
Vancide 51	Liquid	1	--	28	--	40	--	41	--	42	--	32	--	35
" 1:3H_2O	"	1	4	30	6	46	5	42	10	44	9	34	7	38
"	"	2	--	8	--	12	--	14	--	18	--	10	--	10
" 2:2H_2O	"	2	2	3	2	16	2	16	5	18	6	12	8	10
"	"	3	--	4	--	8	--	8	--	5	--	4	--	4
"	"	4	T	T	T	1	T	2	1	1	1	1	1	2
"	"	6	0	0	T	T	0	0	T	0	0	T	1	1
"	"	8	--	T	--	T	--	0	--	0	--	T	--	T
"	"	10	--	0	--	0	--	0	--	T	--	0	--	T
Arasan	Dust	2	--	14	--	16	--	28	--	26	--	12	--	12
Spergon	Dust	3	0	6	1	10	1	10	0	8	0	6	0	7
Copper carbonate	Dust	3	T	8	0	8	1	6	1	8	0	8	1	10

[a] Planted in triplicated 10-foot rows except "no treatment" which was planted in 9 rows for each date of planting. Red Chief wheat used in 1951, and Red Chief and MoKing each used in 1952.
[b] Planted within 5 minutes after treating.
[c] Panogen 1.5 used in 1952.
[d] T = trace or 0.1 to 0.5 percent.

Table 2. Effect of seed treatment with new as compared with older fungicides on the control of smut in Kanota oats, Manhattan, Kansas, 1951 and 1952[a].

Seed treatment			Days planted after treating											
			0[b]		1		2		4		8		16	
Fungicide	Form	Rate per bushel	1951	1952	1951	1951	1952	1951	1952	1951	1952	1951	1952
		oz.	Percentage smutted heads											
Not treated	-----	-----	71	75	75	67	72	72	62	62	65	53	41
Panogen 1.4[c]	Liquid	1/2	38	42	8	2	4	T[d]	1	0	1	0	0
"	"	3/4	17	25	2	2	2	0	0	0	0	0	0
"	"	1	10	18	0	T	0	0	1	0	1	0	0
"	"	1 1/4	8	12	T	T	0	0	0	0	0	0	0
"	"	1 1/2	2	10	T	T	0	0	T	0	T	0	0
Panogen 1.5 1:4H_2O	Liquid	1/2	--	47	--	--	7	--	4	--	3	--	1
" "	"	3/4	--	27	--	--	2	--	1	--	0	--	0
" "	"	1	--	18	--	--	0	--	T	--	0	--	0
" "	"	1 1/4	--	11	--	--	T	--	0	--	0	--	0
" "	"	1 1/2	--	5	--	--	0	--	T	--	0	--	0
Panogen 1.5 1:9H_2O	Liquid	1/2	--	42	--	--	5	--	2	--	1	--	0
" "	"	3/4	--	22	--	--	1	--	T	--	1	--	0
" "	"	1	--	15	--	--	0	--	T	--	0	--	T
" "	"	1 1/4	--	11	--	--	T	--	T	--	0	--	0
" "	"	1 1/2	--	8	--	--	0	--	T	--	0	--	0
Panogen 1.7	Liquid	1/2	23	--	5	1	--	T	--	T	--	0	--
"	"	3/4	7	--	T	1	--	0	--	0	--	0	--
"	"	1	6	--	1	T	--	0	--	0	--	0	--
"	"	1 1/4	6	--	T	1	--	0	--	0	--	0	--
"	"	1 1/2	T	--	0	T	--	0	--	0	--	0	--
Panogen 2.0	Liquid	1/2	15	28	3	T	2	0	0	0	T	0	0
"	"	3/4	6	22	1	T	T	0	1	0	0	0	0
"	"	1	3	9	0	T	T	0	T	0	0	0	0
"	"	1 1/4	1	9	0	0	T	0	T	0	0	0	0
"	"	1 1/2	T	4	0	0	T	0	0	0	0	0	0
Panogen 2.3[e]	Liquid	1/2	17	18	1	1	1	0	1	0	0	0	0
"	"	3/4	7	13	0	T	0	0	T	0	T	0	0
"	"	1	2	7	T	0	T	0	T	0	0	0	0
"	"	1 1/4	1	5	T	T	T	0	T	0	0	0	0
"	"	1 1/2	T	2	0	T	0	0	T	0	0	0	0
Ceresan M	Slurry	1/4	--	47	--	--	33	--	18	--	10	--	3
"	"	1/2	22	32	6	3	16	1	6	0	5	0	1
"	"	1	8	9	3	2	2	T	2	0	2	0	0
N. I. Ceresan	Dust	1/4	--	38	--	--	5	--	3	--	3	--	0
"	"	1/2	14	14	3	1	2	0	1	0	1	0	0
"	"	1	4	5	T	T	1	0	1	0	0	0	0
Agrox	Slurry	1/2	--	36	--	--	15	--	7	--	8	--	4
"	"	1	--	11	--	--	5	--	2	--	2	--	2
Setrete 1 1/2:8H_2O	Liquid	1/2	--	28	--	--	9	--	4	--	5	--	4
" "	"	1	--	7	--	--	5	--	3	--	2	--	2
Vancide 51	Liquid	8	4	3	13	42	4	65	6	58	6	43	8
Arasan	Dust	4	23	15	20	37	12	52	12	57	13	41	9
Spergon	Dust	4	27	18	24	37	9	47	12	54	16	44	9

[a] Planted in triplicated 10-foot rows except "no treatment" which was planted in 9 rows for each date of planting.
[b] Planted within 5 minutes after treating.
[c] Panogen 1.5 used in 1952.
[d] T = trace or 0.1 to 0.5 percent.
[e] Panogen 2.5 used in 1952.

and copper carbonate showed no correlation between storage period and incidence of bunt. More effective control of bunt was obtained in 1951 than in 1952.

When Vancide was increased from 1 to 4 ounces per bushel there was a corresponding decrease in the incidence of bunt. Rates of 4, 6, 8, and 10 ounces per bushel were about equally effective in control of this disease. Full strength Vancide at 1 and 2 ounces per bushel was slightly more effective than when diluted with water. Vancide at 4 or more ounces per bushel was the only nonvolatile fungicide to give satisfactory control of bunt.

Oat Smut -- Under the severe conditions of these experiments highly satisfactory infection was obtained with oat smut from untreated seed for all dates of planting. From 53 to 75 percent infection occurred in 1951 and from 41 to 75 percent in 1952 (Table 2).

For the volatile mercury fungicides, Panogen, Ceresan M, New Improved Ceresan, Agrox, and Setrete, with an increase both in storage period and in rate per bushel, there was a corresponding definite decrease in incidence of smut. An increase in the concentration of Panogen also caused a corresponding decrease in the incidence of smut. Seed treated with Panogen 1.4 at 3/4 ounce, and New Improved Ceresan at 1/2 ounce, the recommended rates per bushel, produced 3 percent smut or less when planted one day or longer after treating.

Seed treated with Ceresan M, Agrox, and Setrete produced 5 percent smut or less when planted 8, 16, and 4 days, respectively, or longer after treating, indicating that they require longer storage periods than Panogen and New Improved Ceresan, and that under the severe conditions of these experiments, they did not give such satisfactory control.

Panogen, and Panogen diluted 1 to 4 and 1 to 9 with water, gave comparable control of oat smut. Similar results were obtained by Koehler and Bever (4) and Leukel (5).

The nonvolatile fungicides, Vancide, Arasan, and Spergon were not satisfactory in the control of oat smut.

Sorghum Kernel Smut -- Fair infection was obtained from untreated seed in 1950 and 1952 while good infection was obtained in 1951 (Table 3). Seed treated with Panogen at 3/4 ounce, Ceresan M at 1/2 ounce, New Improved Ceresan at 1/2 ounce, Vancide at 2 or more ounces, and Arasan (except for one date of planting in 1950), Arasan SF-X, and Spergon each at 2 ounces per bushel produced 1 percent kernel smut or less. Full strength Panogen and Panogen diluted 1 to 4 with water were comparable in the control of sorghum kernel smut.

Victoria Blight Of Oats -- Highly satisfactory infection was obtained with Victoria blight, and plots which were planted with untreated seed, under the severe conditions of this experiment, yielded only 6 and 4 bushels per acre (Table 4). When the seed was planted 2 days after treating with Panogen at 3/4 ounce per bushel, the yield was 37 bushels per acre; for New Improved Ceresan at 1/2 ounce, the yield was 34 bushels; while for Ceresan M at 1/2 ounce, the yield was 22 bushels, a significantly lower yield. However, when the seed was planted after a storage period of 14 days there was no significant difference in the yields from seed treated with the three fungicides, indicating that a longer storage period was necessary for Ceresan M.

Seed treated with Panogen and New Improved Ceresan at double the recommended rates per bushel increased the yield on both dates of planting.

The nonvolatile fungicides, Vancide and Spergon, were not satisfactory in the control of Victoria blight.

Wheat Emergence -- Significant increases in emergence were obtained with Panogen at 3/4 ounce and Ceresan M at 1/2 ounce in both 1950 and 1951, Vancide at 2, 4, and 6 ounces in 1950 and at 4 and 6 ounces in 1951, and with Arasan and Spergon in 1950 (Table 5). There was no significant difference in emergence between the fungicides at their recommended rates of treatment. Increase in the rate of treatment with the volatile mercury fungicides Panogen, Ceresan M, New Improved Ceresan, and Agrox resulted in significant decreases in emergence in 1950 and slight decreases in 1951. Increases in rate of treatment with Vancide resulted in increases in emergence.

Oat Emergence -- Increases in emergence were obtained with all of the fungicides in 1950 and 1951, with significant increases for Panogen at 3/4 and 1 ounce, Ceresan M at 1/2 ounce, and New Improved Ceresan at 1/2 ounce in 1951 (Table 5). There was no significant difference in emergence between any of the fungicides for either year. Treating with the mercury fungicides at double the recommended rate per bushel had no effect in 1950, while in 1951 it resulted in slight decreases in emergence; however, for Vancide slight increases were obtained.

Sorghum Emergence -- Significant increases in emergence were obtained with all of the fungicides at every rate of treatment and for every year (Table 5). Increase in rate of treatment with the volatile mercury fungicides resulted in an increase in emergence in 1950 and

Table 3. Effect of seed treatment with new as compared with older fungicides on the control of covered kernel smut in Red kafir sorghum, Manhattan, Kansas, 1950, 1951 and 1952[a].

Seed treatment				Days planted after treating						
Fungicide	Form	Rate per bushel	2	14	2	14	0[b]	2	4
			1950		1951		1952		
		oz.	Percentage smutted heads						
No treatment	-----	-----	14	10	52	37	15	24	10
Panogen[c]	Liquid	3/8	--	--	--	--	3	T[d]	0
"	"	3/4	0	0	0	0	1	0	0
"	"	1	--	--	0	0	--	--	--
"	"	1 1/4	--	--	0	0	--	--	--
"	"	1 1/2	0	0	0	0	T	0	0
Panogen 1:4H_2O	Liquid	3/8	--	--	--	--	4	1	1
" "	"	3/4	--	--	--	--	T	0	0
" "	"	1 1/2	--	--	--	--	T	0	0
Ceresan M	Slurry	1/2	0	0	0	0	1	T	T
"	"	1	0	0	0	0	T	0	0
N. I. Ceresan	Dust	1/2	0	0	0	0	T	1	0
"	"	1	0	0	0	0	0	0	0
Vancide 51	Liquid	1	--	--	--	--	4	3	1
" 1:3H_2O	"	1	--	--	T	1	3	1	3
"	"	2	--	--	--	--	0	T	0
" 2:2H_2O	"	2	0	0	0	1	1	T	0
"	"	4	0	0	0	0	0	0	0
"	"	6	0	0	0	0	0	0	0
Arasan	Dust	2	0	2	0	0	1	1	0
Arasan SF-X	Dust	2	--	--	--	--	T	T	0
"	Slurry	2	--	--	--	--	T	1	0
Spergon	Dust	2	0	0	0	0	--	--	--

[a] Planted in triplicated 50 foot rows except "no treatment" which was planted in 6 rows for each date of planting.
[b] Planted within 5 minutes after treating.
[c] Panogen 1.4 used in 1950 and 1951 and 1.5 used in 1952.
[d] T = trace or 0.1 to 0.5 percent.

1952 but had no effect in 1951. In 1952 significantly higher increases in emergence were obtained with Panogen, Ceresan M, and New Improved Ceresan over Agrox and Setrete.

Increase in rate of treatment with Vancide resulted in an increase in emergence every year, with significant increases from seed treated at 2 ounces over that treated at 1 ounce, and significant increases in 1950 and 1952 with seed treated at 4 ounces over that treated at 2 ounces. Only slight increases were obtained with Vancide at 6 ounces over 4 ounces.

Vancide at 1 and 2 ounces per bushel at full strength was more effective in increasing emergence than when it was diluted with water.

The highest increases in emergence were obtained with Vancide at 4 and 6 ounces and Arasan at 2 ounces per bushel, with significant increases over the mercury fungicides at

Table 4. Effect of seed treatment on control of Victoria blight in Osage oats, Manhattan, Kansas, 1951[a].

Seed treatment			Days planted after treating		
Fungicide	Form	Rate per bushel	2	14	Mean
		oz.	Bushels per acre		
Not treated	------	------	6	4	5
Panogen	Liquid	3/4	37	21	29
Panogen	Liquid	1 1/2	41	25	33
N. I. Ceresan	Dust	1/2	34	22	28
N. I. Ceresan	Dust	1	42	24	33
Ceresan M	Slurry	1/2	22	21	22
Vancide 51	Liquid	12	12	5	9
Spergon	Dust	4	7	3	5
Significant difference 5%			7.3	7.3	7.3

[a] Each test planted in 5 randomized replications in 4-row, 10-foot blocks. Center 2 rows harvested.

their recommended rates in 1950.

Wheat, Oat, And Sorghum Emergence -- When all tests are taken into consideration significant increases in emergence were obtained for all of the fungicides with the highest increases for seed treated with Vancide at 4 and 6 ounces and Arasan at 2 ounces. Panogen, Ceresan M, and New Improved Ceresan were comparable in increasing emergence. Higher increases in emergence were obtained at the recommended rates than at double the recommended rates of treatment.

Wheat And Sorghum Emergence One And Two Years After Treating -- Significant increases in emergence of wheat were obtained one year after treating with Panogen at 3/4 ounce, Vancide at 2, 4 and 6 ounces and Arasan at 2 ounces per bushel (Table 6). A slight increase over untreated seed was obtained with Panogen at double the recommended rate, while decreases in emergence were obtained with Ceresan M and New Improved Ceresan. Highest emergence was obtained with Vancide.

For sorghum significant increases in emergence were obtained with all of the fungicides except Vancide at 2 ounces per bushel 2 years after treating. Treating the seed at double the recommended rate per bushel with the volatile mercury fungicides resulted in decreases in emergence for seed treated in 1950 and planted in 1951 and for seed treated in 1951 and planted in 1952. However, for the seed treated in 1950 and planted in 1952 a slight increase was obtained. Higher increases in emergence were obtained from seed treated with Vancide at 4 and 6 ounces per bushel than at 2 ounces per bushel. For sorghum, the highest increases in emergence were obtained in two experiments with Arasan and in one experiment with Panogen.

Summary

The volatile mercury fungicides, Panogen, Ceresan M, New Improved Ceresan, and Agrox, at the recommended rates of treatment, and the nonvolatile, nonmercury fungicide Vancide 51 at 4 or more ounces per bushel were comparable as seed treatments for the control of bunt and the improvement of emergence in wheat.

Panogen, New Improved Ceresan, Ceresan M, Agrox, and Setrete were satisfactory in the control of oat smut; however, a longer storage period was definitely necessary for the last three fungicides.

Panogen, New Improved Ceresan, and Ceresan M were comparable in the control of Vic-

Table 5. Effect of seed treatment with new as compared with older fungicides on emergence of wheat, oats and sorghum, Manhattan, Kansas[a].

Seed treatment				Crop and number of tests								
				Wheat		Oats		Sorghum			Mean[b]	
Fungicide	Form	Rate per bushel		6 1950	6 1951	8 1950	4 1951	4 1950	4 1951	2 1952	34	22
		oz.		Percentage of emergence								
Not treated	-----	-----		52	64	72	64	50	57	28	59	54
Panogen 1.4[c]	Liquid	1/2		--	70	--	--	--	--	56	--	--
"	"	3/4		58	71	78	74	63	71	65	69	65
"	"	1		57	70	--	72	--	72	65	--	--
"	"	1 1/4		--	--	--	--	--	73	72	--	--
"	"	1 1/2		52	69	78	70	66	72	66	68	64
Panogen 1.5	1:4H_2O Liquid	1/2		--	--	--	--	--	--	55	--	--
"	" "	3/4		--	--	--	--	--	--	64	--	--
"	" "	1		--	--	--	--	--	--	64	--	--
"	" "	1 1/4		--	--	--	--	--	--	65	--	--
"	" "	1 1/2		--	--	--	--	--	--	64	--	--
Ceresan M	Slurry	1/2		58	71	76	71	64	73	61	69	66
"	"	1		52	67	76	68	70	72	65	67	64
N. I. Ceresan	Dust	1/2		57	70	77	73	62	72	63	69	65
"	"	1		49	65	77	69	68	72	70	67	63
Agrox	Slurry	1/2		--	69	--	--	--	--	47	--	--
"	"	1		--	67	--	--	--	--	50	--	--
Setrete	1 1/2:8H_2O Liquid	1/2		--	--	--	--	--	--	50	--	--
"	"	1		--	--	--	--	--	--	59	--	--
Vancide 51	Liquid	1		--	--	--	--	--	--	44	--	--
"	1:3H_2O "	1		--	--	--	--	--	64	36	--	--
"	"	2		--	68	--	--	--	--	59	--	--
"	2:2H_2O "	2		58	68	--	66	64	71	54	--	64
"	"	4		59	71	--	69	76	75	71	--	69
"	"	6		61	71	--	70	77	78	72	--	71
Arasan	Dust	2		61	69	78	69	76	78	70	72	70
Arasan SF-X	Dust	2		--	--	--	--	--	--	72	--	--
Spergon	Dust	2		59	68	76	70	68	75	54	69	66
Significant difference 5%				5.9	6.3	7.1	6.6	7.4	5.2	7.7	7.0	6.7

[a] Each test planted in 5 randomized replications with 200 seeds in each 12-foot row.
[b] Means of 34 tests for wheat, oats, and sorghum, and 22 tests for wheat and sorghum.
[c] Panogen 1.5 used in the fall of 1951 for wheat and in the spring of 1952 for sorghum.

Table 6. Effect of seed treatment with new as compared with older fungicides on emergence of wheat and sorghum planted one and two years after treating, Manhattan, Kansas[a].

Seed treatment			Crop, number of years treated, year planted				
			Pawnee and Comanche wheat	Combine and Midland sorghum			
Fungicide	Form	Rate per bushel	1	1	2	1	Mean
			1951	1951	1952	1952	
		oz.	Percentage emergence				
Not treated	------	------	37	34	7	15	23
Panogen 1.4	Liquid	3/4	57	65	41	52	54
Panogen 1.4	Liquid	1 1/2	42	58	46	49	49
Ceresan M	Slurry	1/2	42	60	26	50	44
Ceresan M	Slurry	1	31	52	26	38	37
N. I. Ceresan	Dust	1/2	41	62	27	44	44
N. I. Ceresan	Dust	1	31	57	28	39	39
Vancide 51	Liquid	2[b]	61	47	8	30	36
Vancide 51	Liquid	4	61	59	23	47	48
Vancide 51	Liquid	6	65	59	25	45	48
Arasan	Dust	2	56	63	48	64	58
Spergon	Dust	2	44	56	26	42	42
Significant difference 5%			7.2	6.5	6.8	5.6	6.7

[a] Planted in 5 randomized replications with 200 seeds in each 12 foot rot.
[b] 2 ounces of Vancide + 2 ounces of water.

toria blight with a longer storage period required for Ceresan M.

Panogen, Ceresan M, and New Improved Ceresan produced similar increases in emergence of oats.

All of the fungicides tested, Panogen, Ceresan M, New Improved Ceresan, Vancide at 2 or more ounces per bushel, Arasan, Spergon, gave good control of sorghum kernel smut.

Vancide at 4 and 6 ounces per bushel and Arasan at 2 ounces were most effective in increasing emergence of sorghum. Panogen, Ceresan M, and New Improved Ceresan were comparable in increasing emergence while significantly lower increases were obtained with Agrox and Setrete in 1952 -- the only year they were tested.

Panogen was recommended in Kansas as a seed treatment for wheat, oats, and sorghum in 1951. Additional experiments are being conducted with Agrox, Setrete, and Vancide 51.

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COOPERATIVE SEED-TREATMENT TRIALS -- 1952[1]

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Thirty seed treatments were compared in these trials during 1952. They were as follows: a dry-seed control, a wet-seed control, 10 products applied to seed in both the dust and slurry forms (20 treatments), and 8 other products, 2 applied only as dusts, and 6 applied only as fluids. The comparison was made at 24 stations, 16 of them in Canada and 8 in the United States. Of 58 trials actually carried on, only 3 failed to yield usable data.

The various treatments were tested against wheat bunt (11 trials), oat smut (12 trials), barley smut (14 trials), wheat seedling-blight (9 trials), and flax seed-rot (11 trials). For the wheat bunt trials, artificially-smutted (1-200) seed of the variety Red Bobs was used, the inoculum consisting of mixed spores of Tilletia foetida and T. caries. For the oat smut trials, naturally-smutted seed of the variety Vanguard was used, and as the natural contamination was somewhat light, it was supplemented (1-400) with mixed spores of Ustilago avenae and U. kolleri. Naturally-smutted seed of the variety Sanalta was used for the barley smut trials, the contamination in this case consisting of mixed Ustilago hordei and U. nigra. For the wheat seedling-blight trials the wheat variety Regent, in which about 75 percent of the kernels were naturally infested by Helminthosporium sativum, was used. Lastly, for the flax seed-rot trials, seed of the variety Royal, in which about 50 percent of the seeds had been fractured during threshing, was employed.

A summary of the results obtained in 1952, with the exception of those obtained for Vancide 51, is given in Table 1. The data for Vancide 51 are omitted for the reason that the dosage used was much below that required for this product to obtain good control of seed-borne diseases in the small grains.

In addition to the information contained in Table 1, the following notes concerning the various treatments tested may be of interest. It should be noted that in over-all value as seed dressings, several products may fall in the same rank. Control of smut was considered to be satisfactory if less than 1 percent of smutted heads occurred, although the tolerance set by the Canadian Seed Growers' Association is 0.1 percent.

Agrox C -- This is a non-wettable dust containing 5% mercury derived from a mixture of mercury oxide, phenyl mercury acetate, and ethyl mercury chloride. The product tested in 1952 contains twice as much mercury as the product tested under the same name in 1951. In the 1952 trials Agrox C gave satisfactory control of wheat bunt and oat smut, but only moderate control of barley smut, wheat seedling-blight, and flax seed-rot. In over-all value as a seed dressing it ranked second. It is distributed in Canada by Chipman Chemical Co., Winnipeg, Manitoba.

Bunt-cure -- This is a wettable dust containing 40% hexachlorobenzene. It gives satisfactory control of wheat bunt only, the dust and slurry being equally effective against this disease. In over-all value, the dust ranked eleventh, and the slurry thirteenth. It is distributed in Canada by Canadian Industries, Ltd., Montreal, Quebec.

Ceresan M -- This well-known product was used as a standard with which newer products were compared. It is a wettable dust, containing 3.2% mercury as ethyl mercury p-toluene sulfonanilide. In the 1952 trials both dust and slurry gave satisfactory control of bunt and seedling-blight of wheat, the smuts of oats, and seed-rot of flax, but unsatisfactory control of barley smut. In over-all value both dust and slurry ranked first. It is distributed in Canada by Canadian Industries, Ltd., Montreal, Quebec, and in the United States by E. I. du Pont de Nemours & Co., Wilmington, Delaware.

Formaldehyde -- Only one commercial product containing this chemical was tested. The concentrated solution (37%) was tried at the rate of 1/2 fluid ounce per bushel of seed to determine its value as a seed treatment should it be used in treaters adapted to fluid fungicides. The dosage employed gave satisfactory control of oat smut only. It was found to be toxic to the seed of all four crops and ranked fourteenth in over-all value. The product tested is distributed in Canada by Standard Chemical Company, Ltd., Winnipeg, Manitoba.

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Table 1. Summary of results from cooperative seed treatment trials of 1952.

Treatment		Dose (oz./bu.)[a]		Percentage smut[b]			Germination[c]	
		Cereals	Flax	Wheat	Oats	Barley	Wheat	Flax
Control	(dry seed)[d]	----	----	30.1	8.8	9.8	66.0	37.9
Control	(wet seed)[d]	----	----	32.9	8.3	9.4	66.9	36.5
Agrox C	(dust)	0.5	1.5	0.8	0.1	2.5	72.6	49.2
Bunt-cure	(dust)	0.5	0.5	0.6	9.3	8.4	67.7	36.4
Bunt-cure	(slurry)	0.5	0.5	Tr.[e]	9.5	9.2	65.1	35.6
Ceresan M	(dust)	0.5	1.5	0.9	Tr.	3.9	75.1	52.7
Ceresan M	(slurry)	0.5	1.5	0.2	Tr.	1.9	75.5	52.4
Formaldehyde	(37% solution)	0.5	0.5	1.6	Tr.	1.9	30.1	32.9
Leytosan G. 91	(dust)	2.0	4.0	1.0	0.1	2.5	71.7	41.9
MEMA	(solution)[f]	0.5	1.5	0.9	0.5	3.8	72.4	43.7
Mercury-Lindane	(dust)	1.6	4.0	0.5	Tr.	3.1	67.4	44.9
Mercury-Lindane	(slurry)	1.6	4.0	0.5	0.6	3.1	70.0	43.5
Mergamma	(dust)	1.75	4.5	1.7	0.1	2.5	66.4	42.5
Mergamma	(slurry)	1.75	4.5	0.7	0.2	2.3	70.6	41.3
Merlane	(dust)	2.0[g]	5.0	0.5	Tr.	1.5	69.2	48.6
Merlane	(slurry)	2.0[g]	5.0	Tr.	0.1	1.5	75.0	49.2
Mycon	(dust)	0.75	0.75	2.7	0.4	2.4	69.7	32.8
Mycon	(slurry)	0.75	0.75	0.6	1.4	2.4	66.9	37.7
Panogen 14	(fluid)	0.75	1.5	0.1	Tr.	5.1	76.6	54.2
P.M.A.S.	(fluid)	0.5	1.5	1.6	0.5	7.6	71.8	46.3
Setrete	(fluid)	0.5	1.5	1.4	0.7	5.2	71.4	51.2
Spergon	(dust)	2.0	2.0	0.8	0.6	2.0	76.3	41.6
Spergon	(slurry)	2.0	2.0	6.9	6.1	6.1	66.9	36.8
Tritisan 60%	(dust)	0.5	0.5	1.5	2.7	9.2	66.2	35.8
Tritisan 60%	(slurry)	0.5	0.5	1.0	4.0	8.7	67.1	34.2
Tritisan 40%	(dust)	0.5	0.5	5.4	3.7	10.5	63.2	34.5
Tritisan 40%	(slurry)	0.5	0.5	1.3	4.5	8.5	63.7	34.6
Tritisan 20%	(dust)	0.5	0.5	15.4	5.9	9.3	66.0	36.7
Tritisan 20%	(slurry)	0.5	0.5	13.7	5.9	8.8	66.6	35.9
Least significant difference (5% point)				4.8	2.3	2.3	3.9	4.7

[a] Dose for slurry (23 cc. per 10 lbs. seed) equivalent to that of dust.
[b] Percentage of smutty heads or panicles.
[c] Seedling-blight of wheat and seed-rot of flax.
[d] 23 cc. of water added to 10 lbs. seed.
[e] Less than 0.1%.
[f] Powder dissolved in water and applied at rate of 23 cc. per 10 lbs. seed.
[g] Dose was 2.0 oz./bu. for wheat, 1.43 oz./bu. for oats and barley.

Leytosan G. 91 -- This is a dust containing 43% gamma BHC and 2.5% mercury as phenyl mercury urea. It gave satisfactory control only of oat smut, and moderate control of wheat seedling-blight. In over-all value it ranked fourth. It is distributed in Canada by Leytosan (Canada) Ltd., Winnipeg, Manitoba.

MEMA -- This is a water soluble powder containing 4% mercury as methoxy-ethyl mercury acetate. It gave satisfactory control of oat smut, bunt, and seedling-blight of wheat. This product was not satisfactory against barley smut and flax seed-rot, although it ranked third in over-all value. It is manufactured by the Chipman Chemical Company, Inc., Bound Brook, New Jersey.

Mercury-Lindane -- This is a wettable dust containing 50% gamma BHC and 1.5% mercury

as phenyl mercury acetate. In the 1952 trials, both dust and slurry gave satisfactory control of wheat bunt and oat smut but not of the other three diseases against which it was tested. The dust seemed to be slightly toxic to wheat seed. In over-all value, the slurry ranked fourth and the dust sixth. It is distributed in Canada by Hastings & Sons, Ltd., Winnipeg, Manitoba.

Mergamma -- This is a wettable dust containing 40% gamma BHC and 1.15% mercury as phenyl mercury urea. Both dust and slurry were satisfactory against oat smut, and the slurry was also satisfactory against bunt. In over-all value the slurry ranked second and the dust sixth. It is distributed in the United States by Chipman Chemical Company, Inc., Bound Brook, New Jersey.

Merlane -- This is a wettable dust containing 40% gamma BHC and 1.64% mercury as phenyl mercury acetate and ethyl mercury chloride. Both dust and slurry gave satisfactory control of wheat bunt and oat smut. The slurry was also satisfactory against seedling-blight of wheat. In over-all value the slurry ranked second and the dust third. It is distributed in Canada by Sherwin Williams Company, Ltd., Montreal, Quebec.

Mycon -- This is a wettable dust containing 7.7% methyl arsine sulfide (4.7% arsenic). The dust gave satisfactory control only of oat smut, and the slurry only of bunt. It was moderately toxic to wheat and flax and, when applied to seed as a slurry, slightly toxic to wheat and moderately to oats. In over-all value the dust ranked seventh and the slurry eighth. It is distributed by the Pittsburgh Agricultural Chemical Co., New York, New York.

Panogen 14 -- This is a fluid containing 1.4% mercury as methyl mercury dicyan-diamide in a water-miscible carrier. (The older Panogen 14 had an oil carrier.) It controlled bunt, oat smut, wheat seedling-blight, and flax seed-rot. In over-all value it ranked second. It is distributed by Panogen, Inc., Winnipeg, Manitoba.

P.M.A.S. -- This is a fluid containing 3% mercury as phenyl mercury ammonium acetate. It was not so effective as the P.M.A.S. (6% Hg) tested in 1951, and gave satisfactory control of oat smut only. In over-all value it ranked fifth. It is distributed in Canada by the Standard Chemical Company, Ltd., Winnipeg, Manitoba.

Setrete -- This is a fluid containing 4% mercury as phenyl mercury ammonium acetate. It was found to be satisfactory against oat smut and flax seed-rot only, although it ranked second in over-all value. It is distributed in the United States by the W. A. Cleary Corporation, New Brunswick, New Jersey.

Spergon -- This is a wettable dust containing 98% chloranil. For some unknown reason the dust proved to be a far better seed treatment than the slurry, as in over-all value the dust ranked first while the slurry ranked ninth. The dust gave satisfactory control of wheat bunt, oat smut, and wheat seedling-blight, but the slurry failed to control satisfactorily any of the diseases against which it was tested. It is distributed in Canada by Naugatuck Chemicals, Dominion Rubber Company, Ltd., Elmira, Ontario, and in the United States by the United States Rubber Company, Naugatuck Chemical Division, Naugatuck, Connecticut.

Tritisan -- Three wettable dusts, containing 60%, 40%, and 20% pentachlornitrobenzene, were tested in 1952. The 60% dust proved to be moderately effective against wheat bunt only, while the 40% and 20% dusts were not effective. When used as slurries, the three products gave about the same results as the dusts, and in over-all value as seed treatments the 60% dust ranked seventh, the 40% dust twelfth, and the 20% dust fourteenth, while the 60% slurry ranked ninth, the 40% slurry tenth, and the 20% slurry eleventh. It is distributed in Canada by WEB and Co., Montreal, Quebec.

The following cooperators assisted with the 1952 trials: Ames, Iowa (Dr. C. S. Reddy); Beaverlodge, Alberta (Messrs. A. A. Guitard and E. C. Stacey); Bozeman, Montana (Dr. E. R. Hehn); Brandon, Manitoba (Mr. W. H. Johnston); Brookings, South Dakota (Dr. J. T. Slykhuis); Edmonton, Alberta (Drs. A. W. Henry and L. E. Tyner); Fargo, North Dakota (Dr. W. E. Brentzel); Geneva, New York (Dr. W. Crosier); Guelph, Ontario (Mr. E. T. Reeder and Dr. D. N. Huntley); Indian Head, Saskatchewan (Messrs. J. G. Davidson and A. L. Martin); Lacombe, Alberta (Messrs. A. D. McFadden and E. C. Lowe); Lethbridge, Alberta (Drs. M. N. Grant and M. W. Cormack); Madison, Wisconsin (Dr. D. C. Arny); Melfort, Saskatchewan (Mr. H. R. Ballantyne); Morden, Manitoba (Mr. W. J. Breakey); Ottawa, Ontario (Dr. A. J. Skolko and Mr. V. R. Wallen); Pullman, Washington (Dr. C. S. Holton);

Saskatoon, Saskatchewan (Dr. R. C. Russell); Ste. Anne de la Pocatiere, Quebec (Dr. R. O. Lachance); St. Paul, Minnesota (Mr. M. B. Moore); Scott, Saskatchewan (Mr. A. G. Kusch); Swift Current, Saskatchewan (Mr. D. S. McBean); Winnipeg, Manitoba (Mr. H. A. H. Wallace).

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MODE OF ACTION OF HEXACHLOROBENZENE ON WHEAT BUNT FUNGI IN VITRO

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Certain benzene derivatives have been tested recently as possible bunticides for the prevention of stinking smut of wheat. Hexachlorobenzene (HCB), in particular, has shown promising results among a number of polychlorobenzenes tested (3). In experiments carried out in France, Yersin, et al., (7), Lansade (3), and Lhoste (5) showed that effective control of bunt (Tilletia caries (DC.) Tul.) was obtained by the application of HCB in various forms of seed treatment, viz., immersion, sprinkling, and dusting. Dry treatment of seed at a dosage of 8 gm of HCB to 100 kg seed (.16 oz./bu.) gave complete control of bunt. The inoculum had been applied at the rate of 300 mg per kg seed (5) (a spore dosage of 1 to 3300). In the United States, Leukel (4), and Holton and Woo (2) obtained similar results in both spring and winter wheats when either Anticarie[2] or HCB (24% and 60%) were applied as dusts at one-half oz. per bushel. Slurry application of Anticarie was also effective on spring wheat (2). One-half ounce of Anticarie (40% HCB) per bushel is equal to a dosage of 20 grams of pure HCB to 100 kg seed, a figure comparable to that reported by French workers.

In the winter wheat areas of the Pacific Northwest, control of dwarf bunt is difficult primarily because of soil infestation, which renders ordinary seed treatment ineffective. To be effective against this smut, therefore, a fungicide should possess certain properties that make it capable of protecting the susceptible seedlings from infection by soil-borne inoculum. The possibility that HCB is such a material is indicated in the results from soil-application trials with four fungicides reported by Holton and Jackson (1). It was found that Anticarie gave significant control of dwarf bunt in three out of four locations, whereas the other three materials (Ceresan M, Agrox, and Spergon) were ineffective. Since all of these materials are toxic to wheat bunt spores, these results suggest that HCB possesses bunticidal properties entirely different from the other materials used. An attempt was made to determine the mode of action of HCB.

It was suggested that the prophylactic action of Anticarie on dwarf bunt spores might be due to the sublimation of HCB in the soil. Some preliminary trials, therefore, were made to determine whether the vapor of HCB inhibits germination of the bunt spores under laboratory conditions. The results of similar studies were reported by Lhoste (5). Since germination of dwarf bunt spores cannot be satisfactorily induced, spores of Tilletia caries race 9 and T. foetida race 8 were used in these experiments.

Different amounts of HCB[3] (0.1, 1, 5, and 10 mg) were placed in separate small glass vials, each of which was at the center of a Petri dish containing 10 ml of 2% water agar. The solid material of HCB was thus kept from physical contact with the medium. Spores of Tilletia caries and T. foetida were sown on separate agar plates and incubated at 20° C. The Petri dishes were sealed with rubber seals to prevent escape of HCB vapor. Readings of spore germination were taken after seven to ten days. In the control plates 89.4 percent of the spores germinated. In the plates treated with 0.1, 1, and 5 mg of HCB, the percentages of germination were 32.5, 17.2, and 7.4, respectively. It was found that a minimum of 10 mg of HCB was required to completely inhibit spore germination in a 10 cm Petri dish incubated at 20° C. for seven days. Repeated trials gave similar results, supporting the evidence recently reported by Lhoste (5) that HCB vapor actively inhibits germination of bunt spores.

Some experiments were conducted to learn if the temperature of HCB exerts any influence on spore germination. Petri dishes, each containing 10 mg of HCB, were incubated at 10°, 15°, and 20° C for seven to ten days. The percentages of spore germination were 4.8, 1.3, and 0 at 10°, 15°, and 20° C respectively. There was 80 to 90 percent spore germination in the control plates. In further experiments, wide-mouth quart jars containing 150 mg of HCB were held at 60° C for 24 hours with a view to hastening sublimation. Small Petri dishes, previously sown with spores of either T. caries or T. foetida, were placed in these Mason jars and incubated at 10°, 15°, and 20° C for germination studies. At the end of seven to ten days, no germination was observed in any of the plates incubated at these temperatures, while all

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[2]Anticarie is a commercial product containing 20% to 40% HCB as manufactured by H. P. Rossiger & Co., New York, and by French Dyestuffs Ltd., Hamilton, Ontario, Canada.

[3]Thanks are due to H. P. Rossiger & Co., New York, for the supply of Pure HCB used in this investigation.

of the control plates showed more than 80 percent germination. These results seem to indicate that temperature, within the above range, bears no effect on the inhibitory action of HCB on spore germination other than indirectly on the rate of sublimation.

An attempt was made to learn whether the detrimental effect on spore germination exhibited by HCB is fungistatic or fungicidal. Some plates containing spores that had been exposed to HCB vapor for three to seven days were allowed to incubate in the open. Results were inconsistent in a number of tests, but indications were that viability of these spores was related to length of exposure, temperature at exposure time, and amount of HCB used. It can be stated only tentatively that the spores of both T. caries and T. foetida were unable to germinate when they had been held in the jars with 150 mg of HCB for seven days at 20° C. In other words it seems that the inhibitory effect of HCB may finally become fungicidal if the spores are exposed to it for a prolonged period. It is worthy of note that spore germination in the presence of HCB was mostly atypical and the production of both primary sporidia and basidiospores was greatly suppressed.

Although hexachlorobenzene sublimes at room temperature, the degree is almost negligible. The vapor pressure of HCB at 20° C, as calculated from the formula given by Sears and Hopke (6), was 1.089×10^{-5} mm of Hg. Similarly, the vapor pressure of HCB at 5°, 10°, and 15° C was found to be 1.429×10^{-6}, 2.871×10^{-6}, and 5.662×10^{-6} mm, respectively. The gaseous volume percentage is equal to $\frac{p}{P} \times 100$, where p is the partial pressure of vapor, and P the total pressure. Since the total pressure P differed but slightly from the normal barometric pressure of 760 mm, the value P was regarded as equal to 760 mm in all calculations. The vapor concentration of HCB at 20° C therefore would be 14.33×10^{-7} percent.

If the free air space in the Petri dish, exclusive of the volume of agar and vial, be 85.43 ml, the theoretical amount of HCB required to give such a maximum vapor concentration of 14.33×10^{-7} percent at 20° C as calculated from the gas law would be 1.45×10^{-5} mg. The extraordinary action on Tilletia spores by this amount of HCB vapor seems very striking.

Theoretically only 1.45×10^{-5} mg of solid material of HCB was needed to inhibit spore germination in a 10 cm Petri dish at 20° C. It is doubtful, however, that this equilibrium can ever be reached under practical conditions. It was found that 10 mg of HCB was required to completely inhibit spore germination under these conditions. When smaller amounts of HCB were used, the percentages of spore germination increased proportionally. Many of these spores may have germinated before a threshold vapor concentration in the dish was reached. In the application of this fungicide, particularly to the soil, it is desirable that sufficient HCB material be used to release a vapor concentration that will inhibit spore germination in a few days at a particular temperature range.

From the results obtained in the foregoing experiments, it can thus be concluded that the effective control of dwarf bunt as well as common bunt of wheat by HCB is primarily due to the inhibitory action of the vapor on spore germination. As HCB sublimes only slightly at room temperatures, the threshold vapor concentration necessary for complete inhibition of spore germination has not been determined. From calculated data it appears that the possible maximum concentration of HCB at 20° C cannot be more than 14.33×10^{-7} percent. In field practice, the efficiency of control is dependent on the concentration of vapor given off by the HCB in the soil. The rate of sublimation may be affected by the method of application, the nature of filler, the temperature, moisture, and texture of the soil, and many other factors. From a theoretical point of view, and because of the possibility of practical bunt control, it seems highly desirable that further research on the action of HCB be pursued.

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COOPERATIVE INVESTIGATIONS BETWEEN THE U. S. DEPARTMENT OF AGRICULTURE, AGRICULTURAL RESEARCH ADMINISTRATION, BUREAU OF PLANT INDUSTRY, SOILS AND AGRICULTURAL ENGINEERING, DIVISION OF CEREAL CROPS AND DISEASES, AND THE WASHINGTON AGRICULTURAL EXPERIMENT STATIONS.

TREATMENT OF VEGETABLE SEED OF LOW GERMINATION[1]

V. R. Wallen and A. J. Skolko[2]

The extent of the reduction in germinative capacity of vegetable seed held in storage is largely determined by the conditions of storage, the fungus flora associated with the seed, and the kind of seed concerned. However, the reduction in emergence in field tests of seeds after long storage periods is usually much more severe than laboratory germination tests might indicate and can be attributed to loss of vigour of the seedlings, which succumb to weakly pathogenic fungi in the soil. The use of protectant seed dressings on such seed can be expected to provide highly beneficial results and the present report would appear to bear this out.

In addition to the fungicidal seed dressings generally recommended for vegetable seed treatment, a number of liquid seed dressings, such as Panogen and P.M.A.S., were included in the tests, for the reason that in recent years many seed treating plants have purchased treating machines for the application of liquid seed dressings to cereal and flax seed, but information on the suitability of these materials for treatment of vegetable seeds is meagre.

Panogen was reported as being suitable for seed treatment of Round Pod Kidney Wax beans for the control of damping-off in field plots (2). Jacks (3) found that Panogen gave the greatest significant increased emergence of healthy seedlings for lettuce at 0.5 percent by weight, for beets at 0.5 and 2.0 percent, for peas at 1.0 percent, for beans at 1.0 percent, for tomato at 2.0 percent, but no significant increase was found for celery or turnip. The minimum effective dosages which he selected were lettuce 0.25, peas 0.25, beans 0.25, beet 0.5, and tomato 1.0 percent. Jacks also noted that Panogen treatment resulted in considerable phytocidal damage on lettuce at 2 percent by weight dosage, while turnip, beet, and celery were sensitive to Panogen overdose. He also found that storage for ten months after treatment with Panogen did not affect stand except in lettuce and turnip. Panogen 14, applied at the rate of 2 1/2 ounces per bushel, was found to cause injury to corn in storage (1).

In the present study fairly large quantities of vegetable seed were secured in order that accurate dosages of the seed dressing could be applied. Samples of the seed of each vegetable were plated on malt agar to determine the presence of pathogenic fungi. In Table 1 the data on source of seed, age of seed, fungi present, etc., are summarized. It may be noted that the seed was several years old and that the germination in some lots was very low both in the plate test and later in the soil. The seed dressings included in the test and the dosages at which they were applied are listed below (conforming to prescribed rates of application where available).

Arasan (tetramethyl thiuramdisulfide): 2 oz. per 100 lb. of seed for beans, corn, cucumber, peas, and squash; 4 oz. per 100 lb. for broccoli, carrot, cabbage, cauliflower, lettuce, onion, radish, spinach, and tomato; 8 oz. per 100 lb. for beet.

Panogen (methyl mercury dicyan diamide): 4 fl. oz. per 100 lb. of seed for all vegetables.

P.M.A.S. (phenyl mercury acetate): 4 fl. oz. per 100 lb. seed for all vegetables.

Phygon (dichloronaphthoquinone): 1 1/2 oz. per 100 lb. seed for corn; 2 oz. per 100 lb. seed for beans and peas; 4 oz. per 100 lb. seed for broccoli, cucumber, cabbage, cauliflower, onion, radish, spinach, squash, and tomato; 6 oz. per 100 lb. seed for beet, carrot, and lettuce.

Spergon (tetrachloro-parabenzoquinone): 3 oz. per 100 lb. seed for beans, corn, and peas; 6 oz. per 100 lb. seed for cucumber and squash; 8 oz. per 100 lb. seed for broccoli, cabbage, cauliflower, onion, radish, spinach, and tomato; 12 oz. per 100 lb. seed for carrot and lettuce; 16 oz. per 100 lb. seed for beet.

Vancide 51 (sodium salt of dimethyl dithiocarbamic acid + sodium salt of 2-mercaptobenzothiazole): 4 fl. oz. per 100 lb. seed for broccoli, cabbage, cauliflower, onion, radish, and spinach; 5 fl. oz. per bu. for corn; 5 fl. oz. per 100 lb. for squash; 6 fl. oz. per 100 lb. for carrot and lettuce; 8 fl. oz. per 100 lb. for beet and peas; 1% solution dip for cucumber; and 5% solution dip for beans and tomato.

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Table 1. List of vegetables included in seed treatment tests.

Kind	Variety	Source of seed	Year of Harvest	Agar plate test: Percent Germination	Agar plate test: Percent fungi present: Pathogenic	Agar plate test: Percent fungi present: Total
Bean	Giant Stringless Green Pod	Summerland, B. C.	1947	98	0	8
Beet	Detroit Dark Red #16	University of Manitoba	1944	9	0	9
Broccoli	Green Sprouting	Summerland	1943	69	0	0
Cabbage	Penn State Balhead	Ste. Clothilde, Que.	1949	80	0	6
Carrot	Chantenay #37	Summerland	1948	77	0	4
Corn [Maize]	Banting S. C. 50	Ste. Clothilde	1950	88	3[a]	27
Cauliflower	Snowball Perfected	Saanichton, B. C.	1949	94	2[b]	7
Cucumber	Davis Perfect	Summerland	1946	82	0	0
Lettuce	Green Rapids	Ottawa, Ont.	1947	68	0	2
Onion	Red Wethersfield	Ottawa	1947	13	0	11
Peas	Little Marvel	L'Assomption, Que.	1948	89	0	14
Radish	French Breakfast	Saanichton	1950	100	0	22
Squash	Kitchenette	Ottawa	1946	72	0	1
Spinach	Bloomsdale Longstanding	Saanichton	1948	60	0	18
Tomato	Harkness	Vineland, Ont.	?	93	0	0

[a] Nigrospora sphaerica 2 percent and Fusarium moniliforme 1 percent.
[b] Alternaria brassicicola 2 percent.

Table 2. Mean percentage field emergence of vegetable seed treated with various seed dressings, based on four samples of 100 seeds each.

Kind of seed	Untreated	Arasan	Panogen	P.M.A.S.	Phygon	Spergon	Vancide 51	L.S.D.[a]
Beans	90.0	93.0	85.8	95.5	94.0	93.5	86.0	4.4
Beet	42.5	68.8	97.0	35.8	91.5	41.0	34.3	21.3
Broccoli	36.0	36.3	39.3	41.5	38.5	49.0	30.0	8.7
Cabbage	65.5	60.0	54.3	58.8	64.5	75.5	50.5	6.4
Carrot	57.0	57.8	67.8	55.5	65.8	67.0	56.8	---[b]
Cauliflower	66.0	72.0	74.5	71.0	75.3	72.5	63.5	---
Corn	80.8	85.5	82.5	82.5	87.8	84.0	86.8	---
Cucumber	38.0	71.8	63.0	59.5	71.3	69.0	69.8	7.4
Lettuce	27.8	28.3	19.8	17.3	21.8	27.0	24.8	---
Onion	41.0	49.0	36.8	36.8	46.5	42.0	44.0	---
Peas	68.5	78.5	80.3	81.5	83.8	80.8	83.0	4.5
Radish	80.0	89.3	88.8	84.0	86.5	88.8	85.3	---
Spinach	21.0	49.3	53.5	17.3	67.0	15.5	19.3	7.6
Squash	10.0	15.3	59.8	13.8	45.5	12.3	8.5	10.8
Tomato	41.5	59.8	73.8	39.8	66.0	60.8	59.5	12.6

[a] L.S.D. at the 5% level.
[b] No significance between treatments.

The seed was weighed out in half-pound lots for each of six treatments and for each kind of vegetable seed, and the seed dressing was applied by placing the seed in conditioned flasks and shaking in a mechanical shaker for five minutes, except in the treatments involving dipping in a solution of Vancide 51. The seed was kept in open flasks at room temperature for two to three weeks and then planted in 16-foot rows at the rate of 100 seeds per row. Each treatment was replicated four times and randomized. The results of emergence counts are summarized in Table 2.

The increase in emergence of beet seed (Table 2) treated with Panogen and Phygon was outstanding. With Arasan treatment there was a significant increase but P.M.A.S., Spergon, and Vancide 51 showed no appreciable effect. In broccoli, Spergon alone produced a significant increase in emergence. Similarly, with cabbage only Spergon effectively increased emergence whereas Panogen, P.M.A.S., and Vancide 51 resulted in significant reduction in emergence. In cauliflower and radish, although no significance between treatments could be established, all treatments tended to give higher emergence than in the untreated seed.

Squash seed treated with Panogen and Phygon gave greatly increased emergence, especially with the former, while the other treatments were ineffective. Cucumber showed significantly higher emergence with all treatments.

In beans, only P.M.A.S. treatment resulted in higher emergence but the young seedlings were at first chlorotic, a condition that soon disappeared. In peas, all treatments gave increased emergence, as also was true of tomato with the exception of P.M.A.S. Only Phygon, Panogen, and Arasan treatment gave significant increases in spinach. Treatment of corn, onion, lettuce, and carrot seed resulted in no marked benefit, but in corn emergence tended to be somewhat higher with treatment.

In general one may conclude that, with the exception of cabbage seed, Panogen can be safely applied to the vegetable seeds listed above at the dosages employed here. The outstanding effectiveness of Panogen on beet seed corroborates the results obtained by Jacks (3). The performance of Panogen on squash, tomato, spinach, peas, and cucumber is noteworthy, especially in those instances where germination of untreated seed is low.

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LIMA BEAN SEED TREATMENT TRIALS IN MICHIGAN, 1951-52[1]

Donald J. deZeeuw[2] and Axel L. Andersen[3]

Lima bean seed treatment materials have been tested at East Lansing, Michigan for the past two summers as part of the general vegetable seed treatment program. The results for these two years appear to have been in good enough agreement to warrant reporting at this time. As in all such work certain reservations should be kept in mind because of the great variation that can be obtained from year to year and place to place.

Fordhook 242 lima (Ferry-Morse Seed Co.) was selected for these tests because of its extreme sensitivity to damping-off and seed decay. The treatments were completely randomized within blocks and replicated six times each year. Stand counts of surviving normal plants were made 20 days after planting in 1951 and 14 days after in 1952. Table 1 gives the percentage stands obtained for the two years arranged in order of rank for those materials used in both trials. Carbide & Carbon Chemicals Corp. L-224 was used only in 1951 and California Spray-Chemical Corp. Orthocide 75 and HL 609, only in 1952.

Table 1. Percent stand obtained from Fordhook 242 lima bean seed treated as indicated and rank of materials used for treatment, in trials at East Lansing, Michigan, in 1951 and 1952.

1951				1952			
Rank	Material and method of application	Dosage (oz/100 lb. seed)	Percent stand[a]	Rank	Material and method of application	Dosage (oz/100 lb. seed)	Percent stand[b]
1	Arasan SF (slurry)	3	60.4	1	Ceresan M (slurry)	2	52.5
2	Ceresan M (slurry)	2	59.0	2	Ceresan M (dry)	2	44.0
3	Panogen (liquid)	2	57.1	3	Phygon XL (slurry)	4	43.3
4	Arasan (dry)	4	54.2	4	Panogen (liquid)	2	42.5
5	Phygon XL (slurry)	4	53.8	5	Arasan SF-X (slurry)	3	42.3
6	Ceresan M (dry)	2	53.3	6	Vancide 51 (liquid)	6	35.2
7	Phygon XL (dry)	4	50.2	7	Phygón XL (dry)	4	33.7
8	Spergon (slurry)	4	49.6	8	Arasan (dry)	4	29.8
9	Spergon (dry)	4	48.5	9	Spergon (dry)	4	29.6
10	Vancide 51 (liquid)	4	45.4	10	Spergon (slurry)	4	25.6
11	Control	-	44.4	11	Control	-	21.0
	Carbon & Carbide L-224 (dry)	4	25.6		Orthocide 75 (dry)	2	51.9
					Orthocide 75 (slurry)	2	51.7
					Orthocide HL 609 (dry)	3	51.5
L.S.D.				L.S.D.			
	5%		10.9		5%		8.1
	1%		14.5		1%		10.9

[a] 80 seeds per row. Stand counts 20 days from planting.
[b] 80 seeds per row. Stand counts 14 days from planting.

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The damping-off potential appears to have been considerably higher in 1952 than in 1951. This, together with the low replication variance of 1952, would account for the smaller L.S.D. in the latter year and cause more materials to appear significantly beneficial. Highly significant differences were obtained in 1951 with Arasan SF (slurry) and Ceresan M (slurry), whereas Panogen was significantly superior only to the control. None of the others was statistically better than the control. In 1952 all materials except Spergon (slurry) gave significant to highly significant control of damping-off or seed decay. The effectiveness of the treatments was very similar for both years except for the Arasan group. Further tests should be made with these materials to determine whether differences were due to formulation or something else. The disparity between 1951 and 1952 results is greater than is usually to be expected for Arasan. Two mercury materials, Ceresan M and Panogen, improved stands in both years and ranked well toward the top even though lima beans are generally considered mercury-sensitive (1, 3, 6). Experimental material L-224 (mercury-zinc-chromate) was undoubtedly injurious to the seed, a finding that confirms McCallan's results (7, 8). Spergon, a longtime favorite for use on lima bean seed (2, 9), neither compared well with other fungicides nor was clearly superior to the control. McCallan (8) classed chloranil (Spergon) as significantly better than no treatment for lima beans but thiram (Arasan) as highly significantly better. His report, however, was a summary of several tests in different localities and combined two varieties of lima beans which may or may not differ materially in their response to seed treatment and damping-off.

Orthocide 75 seed treater and HL 606 (a combination of Orthocide 75 and lindane) appeared very promising in the 1952 test. The latter material, as well as an Arasan SF and lindane combination is now recommended by Lieby and Chupp (5) for beans in New York state. Apparently these materials are in a class with Ceresan M (slurry) and certainly deserve further testing. Although Vancide 51 was applied at a higher rate in 1952 than in 1951, few or no increased benefits were noticed.

A noteworthy observation was made regarding Phygon XL as a seed protectant for lima beans. The product caused blackening of the cotyledons and prevented the seed coat from splitting so that the cotyledons were restrained abnormally. Because of this, there was usually a slight retardation in the development of the seedling. These effects are not readily noticed under field conditions, but were observed on navy pea beans in foundation bean seed fields in 1952 after Phygon XL (slurry) had been used as a seed protectant. Seed from the 1952 experimental treatments retained for storage tests displayed these effects when germinated in the greenhouse in sand at 60° to 65° F. Much the same sort of phenomenon was reported recently by Hansen for sweet clover seed treated with Phygon (4).

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A TEST FOR DETECTING THE EFFECTS OF MICRO-ORGANISMS AND OF A MICROBIAL ENZYME ON COTTON FIBER

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Progress toward a basic understanding of the problems of deterioration of cotton fiber and toward their practical solution has been limited by the inadequacy of methods available for measuring the changes that occur. A new method of measurement is here described. It was devised after a consideration of the observations and conclusions of a number previous workers who have concerned themselves with the microscopic examination of alkali-swollen cotton fiber.

As is described in a review by Kerr (7), it has been known for many years that the degree of swelling of undamaged cotton fiber in concentrated sodium hydroxide and in other alkaline swelling solutions is limited by a restrictive effect of the thin outer wall of the fiber. It has also been recognized that any of several types of agencies which weaken the outer wall (e.g., micro-organisms, acids, heat, or mechanical shock) thereby cause a decrease in its restrictive action during alkali-swelling and a corresponding visible increase in the degree of swelling of the fiber. Two microscopic tests for damage in cotton fiber, namely the Fleming-Thaysen test (14) and the Congo Red test (1, 2, 3), make use of this principle. Both tests, however, are so time-consuming as to limit their value seriously for either routine or investigative purposes.

The new method consists essentially of simply swelling a known weight of cotton fiber in an NaOH solution, centrifuging off the interfibrillar liquid, and determining the percentage weight increase of the fiber, which is termed the fiber's "alkali-centrifuge value". The technique has been found useful under certain circumstances in detecting the influence on cotton fiber of micro-organisms and of certain enzymatically active filtrates from microbial growth media. The active agency in the filtrates that causes the response in the test is believed to consist principally and possibly entirely of an enzyme of the cellulase complex. The results are also influenced by prior exposure of the fiber to acid, hypochlorite, heat, weathering, and probably other degradative agencies, and are clearly related in the case of undamaged fiber to the thickness of the fiber's secondary wall. The technique may eventually prove useful in tests relating to some of these later-mentioned influences as well as for the study of the microbial and enzymatic effects with which we have had more experience. The test is simple, inexpensive, rapid, quite highly reproducible, involves only standard laboratory equipment, is essentially free from safety hazards to the operator, and is adaptable to use on cotton in several different forms and in various sample sizes.

The method is applied to cotton previously subjected in some manner to micro-organisms, filtrates from microbial growth media, or some other deteriorative agency whose effect it is desired to measure, also frequently to similar but undamaged cotton for comparative purposes. Raw cotton fiber, de-waxed cotton fiber, ravellings from cotton fabric, and in some cases intact cotton fabric, sliver, yarn, and other forms of cotton have been used. The sample size most commonly used has been 250 mg, although limited data indicate that samples as small as 50 mg or as large as 500 mg may also be used with good results in the same procedure. In brief, the method is as follows:

(1) Place a 250-mg sample of the cotton to be tested into 25 cc of water containing 0.05% Aerosol OT and allow it to remain there for 10 minutes.
(2) Remove the sample from the water, blot excess water off it, and transfer it to a suitable flask or bottle with 50 ml of a solution containing 180 grams per liter of NaOH. Shake the sample in the NaOH solution on a mechanical shaker for 15 minutes. The swelling is preferably carried out at constant temperature, 20° C having been used in our experiments.
(3) Filter the fiber out of the solution by the use of a Gooch crucible without suction and transfer it to an 8-ml fritted-disc filter crucible.
(4) Place the fritted-disc crucible, containing the swollen fiber, on top of three short sections of capillary tubing that support it off the botton of a 50 ml centrifuge tube. Cover the tube and centrifuge at a speed of 1200 RPM for 10 minutes, the radius of centrifugation being 14 cm.
(5) Transfer the centrifuged fiber mass to a weighing bottle and determine its percentage increase in weight.

Table 1. Effect of Cladosporium sp. #113 on alkali-centrifuge values and strength of unbleached 8-ounce cotton duck incubated by a previously described method (10) in a saturated atmosphere with the fungus in pure culture.

Days of incubation	Alkali-centrifuge value	Strength (pounds)[a]
0	223	108
2	233	108
3	243	108
4	255	108
7	294	110
14	311	108

Results obtained by the new technique are moderately or highly insensitive to small differences in radius, speed, and time of centrifugation, temperature of swelling, and other test conditions, in contrast to the large differences frequently found to be associated with microbial and enzymatic effects on the fiber.

Table 1 shows results obtained in an experiment in which strips of unbleached cotton fabric were incubated by a simple previously described pure culture technique (10) in a saturated atmosphere after being dusted with spores of Cladosporium #113. It is seen that the alkali-swelling values increased materially, even though the strength remained unchanged. If the humidity is lowered to 95 percent, the alkali-centrifuge change is greatly suppressed or entirely prevented, even though growth of the fungus may be detected by changes in aqueous-extract pH of the fiber (10). If conditions for rapidity of fungus growth are made favorable by the use of a liquid mineral salts medium in contact with the strip, as, for example, in the glass wick-culture bottle method of Greathouse, Klemme, and Barker (5), strength losses occur fairly promptly but the swelling reaction is still much more responsive to the microbial growth than is strength. With this type of incubation, for example, a doubtfully significant fabric strength loss of 5 percent after 24 hours of incubation with the fungus Myrothecium verrucaria was accompanied by an alkali-centrifuge value of 333, the latter representing an increase of at least 10 times the least easily measurable difference.

The alkali-centrifuge test is being used in this laboratory in continuation of earlier studies relating to microbial effects on cotton during weather exposure prior to harvest (10). These effects are measurable under certain conditions by the alkali-centrifuge test, but the changes are generally much less striking than those in aqueous-extract pH of the fiber under similar circumstances (10). The problem of Elting's "cavitomic cotton" (4), a special type of microbially-infested raw cotton, is also being investigated by the use of the test. The technique is often particularly useful where strength losses are too small or for other reasons difficult or impossible to measure.

In preparing filtrates from growth media, the filtration has been carried out routinely by successive use of coarse-, medium-, and fine-porosity sintered-glass filters, preceded by centrifugation if necessary to remove excessive amounts of spores and other suspended matter. Sterile filtrates were prepared with a Morton bacterial filter.

In testing the filtrates, the usual procedure has been to expose 250 mg of well-mixed de-waxed cotton to 25 cc of filtrate in a 250-cc Erlenmeyer flask at 30° C, rinse it in water, and run it through the alkali-centrifuge test described above, either with or without prior drying at 50° C in a circulating oven. Except as is otherwise indicated, the time of exposure to the filtrate has been one hour and the filtrate has not been diluted. The increase in alkali-centrifuge value obtained at the one-hour exposure in comparison with the value for the same fiber unexposed is referred to here as the "S-factor activity" or simply the "activity" of the filtrate, the active agency being called by the term "S factor" in our laboratory. No precise definition of enzyme units is attempted at the present time. In a few early experiments raw rather than de-waxed cotton was used as the test fiber.

When the fungus Myrothecium verrucaria 1334.2 was grown in liquid shaking culture with different carbon sources present in the medium, it was observed that some filtrates were active and others inactive and that all active filtrates were derived from media that contained cellulose in some form (Table 2). The data suggested that the active filtrate factor probably was principally the enzyme cellulase or some element of a cellulase complex. Although these tests were run on unbuffered filtrates, there was no indication from pH values of the filtrates as used that seemed to cast doubt on the adaptive-enzyme interpretation of the data, Table 2. It was indicated, rather, that the active factor was probably operative over a wide pH range, a conclusion substantiated by later experiments. Fusarium #102 was also incubated in the same manner as the Myrothecium, with the essentially similar result that active filtrates

Table 2. Enzyme activity[a] and pH of filtrates from the growth of Myrothecium verrucaria in shaking culture on a mineral salts solution[b] containing various carbon sources as indicated. In all cases moderate to heavy growth occurred, except for only slight visible growth on the wood shavings.

Carbon source in medium	Filtrate activity, i.e. change in alkali-centrifuge values of fiber after exposure to filtrate for:			pH of filtrate
	1/2 hr.	1 hr.	4 hrs.	
Cellulosic C-sources				
Bacterial cellulose[c]	16	22	74	6.5
Carboxymethyl cellulose[d]	34	59	110	6.9
Cellophane	56	92	122	5.8
Cuprammonium rayon	33	74	121	5.5
Filter paper (acid-washed)	22	11	39	5.1
Filter paper (qualitative)	46	62	108	5.0
Flax fiber	60	81	135	5.0
Manila hemp	83	99	156	5.3
Raw cotton	143	148	161	5.3
Wood shavings	55	105	153	6.2
Non-cellulosic C-sources				
Asparagine	-1	2	1	8.4
Cellobiose	-2	-2	0	5.8
Cotton extract[e]	-4	-4	-5	7.8
Cottonseed oil	7	6	9	4.6
Gelatine	-14	5	1	8.4
Glucose	-6	-4	-6	6.4
Glucose plus cotton extract	3	-6	0	8.0
Glycerine	-7	2	8	5.8
Lactose	-8	-7	-5	5.3
Malic acid	-2	-1	-1	6.4
Pectin	-4	0	8	7.1
Peptone	-10	-9	-12	5.2[f]
Starch	-8	9	0	4.8
Sucrose	-2	10	10	5.5
Wool (autoclaved 2 hrs.)	-2	1	-6	7.5

[a] In terms of change in alkali-centrifuge values of a test fiber as a result of exposure to the filtrate, see explanation in text. This experiment was conducted at an early period in our experience with the alkali-centrifuge test and the results consequently are slightly less accurate than in later experiments.

[b] 1.0 g.p.l. NH_4NO_3, 0.90 g.p.l. KH_2PO_4, 0.70 g.p.l. K_2HPO_4, and 0.75 g.p.l. $MgSO_4 \cdot 7H_2O$. Reference to "mineral salts" throughout this paper indicates a medium of this composition.

[c] Membrane from growth of Actobacter xylinum, purified by washing successively with dilute NaOH, dilute acetic acid, and water.

[d] "Carbose I", from Wyandotte Chemical Co., 250 mg of which was autoclaved at 15 lbs. for 15 minutes in the mineral salts medium and the undissolved residue removed before inoculation.

[e] Made by kneading 50 g of raw cotton at room temperature with 500 cc of water. In the cotton-extract tests the salts were simply added to this medium rather than to distilled water.

[f] Filtrate buffered.

were produced during growth on raw cotton, manila hemp, and cuprammonium rayon, but not on glucose, cellobiose, starch, pectin, cottonseed oil, or gelatin. With these filtrates a buffer was used; the buffer was not entirely effective, the pH's varying between 4.2 and 5.2. Aspergillus terreus, A. flavipes, and Thielavia sp. also produced active filtrates when grown on cotton fiber but not when grown on glucose. In a test with Myrothecium and with Fusarium 102 to determine whether active filtrates might be produced with low concentrations of glucose, from 0.2% to 0.02%, only inactive filtrates occurred.

This evidence on the adaptive nature of the S factor was supplemented by the results of another type of test, in which Cladosporium #113 and Fusarium #102 were incubated with a cotton fabric strip in a glass wick-mineral salts system (5). The addition of 1% of glucose to the liquid mineral salts growth medium markedly depressed the increase in alkali-centrifuge value and loss in strength of the strip, and also depressed the S-factor activity of the culture fluid as measured after the incubation. An equal concentration of glucose added directly to an active filtrate had little if any effect on its activity.

Subsequently it was noted that a very simple static culture method is well suited to the production of active filtrates by Myrothecium or by any of numerous other fungi. One-gram mats of raw cotton were placed into 500-cc Erlenmeyer flasks, saturated with 40 cc of a mineral-salts solution (Table 2, footnote[b]), autoclaved, and incubated for seven days at 30° C under pure culture conditions with various fungi. The activity values of filtrates from the growth media of several fungi grown in this manner were as follows: Alternaria sp., 39; Aspergillus flavipes, 126; Chaetomium globosum, 140; Cladosporium sp., 138; Diplodia gossypina, 104; Fusarium moniliforme, 161; Humicola sp., 48; Myrothecium verrucaria, 156; Penicillium simplicissimum, 173, and Thielavia sp., 151. The degree to which filtrates so produced may be diluted and still give significant swelling responses depends greatly on the fungus used. Of the fungi just mentioned, the Myrothecium, Cladosporium, Fusarium, and Thielavia all produced filtrates yielding highly significant swelling responses at a 100-fold dilution with water. Except as otherwise indicated, Myrothecium filtrate prepared in this manner was used in the tests described in the following sections.

Several observations on the production and properties of Myrothecium filtrates may be summarized briefly. Activity regularly exceeds 100 when the filtrate is produced in the cotton mat procedure described. When a constant source of cotton is used for the incubation mats, the activity is quite uniform. Values of 151, 146, 148, 150, and 153 were obtained, for example, in five incubations at different times with subsamples from a single large cotton sample used in the mat. The enzyme is present in old as well as young Myrothecium cotton mat cultures, tests on filtrates from cultures of 1, 2, 3, 4, 5, and 6 weeks of age yielding activity values of 151, 136, 117, 113, 116, and 107 respectively. Capacity to produce the enzyme was indicated to be a relatively stable property in the sense that it was not lost upon repeated transfer of the fungus on a medium containing glucose as the sole carbon source. Mass inoculations were made upon glucose-mineral salts agar 12 times in succession, after which 12 single-spore isolations were made on a glucose-mineral salts agar medium from the twelfth mass culture. Upon their first transfer to a cotton mat and incubation in the usual manner, the 12 isolates produced filtrates with activities of 120, 126, 131, 132, 137, 132, 126, 133, 136, 130, 127, and 127.

The centrifuge-measured activity of the filtrate is accompanied by pronounced increases in alkali-swollen fiber width and in Congo Red values. Autoclaving of filtrate for two hours completely destroyed activity as measured by all three criteria. In other tests, results also not shown, partial heat inactivation has been observed in 30 minutes at 50° C. At successively higher temperatures, however, the activity, as tested at 30° C shortly after the heating period, has repeatedly failed to exhibit a smoothly declining trend with increasing temperature and in some cases highly significant activity has been observed even after 30-minute heating at 100° C. The extent of inactivation at temperatures above 60° is apparently greatly dependent on salt content or pH of the filtrate or upon some other as yet unknown factor.

In an experiment with different temperatures during the actual period of exposure of the test fiber to the filtrate, activity was observed to increase with temperature up to at least 45° C. In this test, with filtrate diluted 25 times with water, the values obtained at 5-degree intervals from 5° to 45° C were 43, 49, 51, 62, 66, 68, 83, 86, and 107. The effect of pH on the reaction has not been exhaustively studied, but it is obvious that high activity may be observed in at least some systems over a wide pH range. Thus, in an experiment with citrate-ammonia buffer the following pH and activity values were recorded: 3.5, 60; 3.9, 85; 4.3, 120; 4.6, 124; 5.0, 113; 5.4, 114; 5.7, 102; 6.2, 107; 6.7, 105; 7.0, 78; 7.2, 105; 7.5, 108; 8.0, 87; 8.3, 76; and 8.9, 58. Certain simple neutral salts have been found to depress

activity. In an experiment with filtrate diluted 25 times with water, the control sample activity value of 73 was lowered to 34, 55, 53, and 49 as a result of the presence of KCl, NaCl, $CaCl_2$, and $MgSO_4$ respectively at a final concentration of only 0.01 M. Filtrate is highly effective as compared with HCl or NaOCl in its effect on the centrifuge value of the fiber under the standard test conditions at 30° C, a filtrate diluted 25 times with water causing almost as large an increase in centrifuge value as 10 M HCl and a larger increase than .17 M NaOCl. Drying at moderate temperatures has little effect on the activity of the enzyme. Thus, a filtrate diluted 5, 10, 25, 50, and 100 times exhibited an activity of 106, 91, 68, 54, and 38 at these dilutions respectively, whereas similarly diluted solutions reduced to dryness at 40° C in a forced-draft oven and then restored to their original volume with water and tested yielded values of 105, 90, 70, 53, and 34. Similarly diluted and dried filtrates that were allowed to remain dry for four weeks before being restored to volume with water and tested yielded values of 97, 84, 61, 52, and 38.

If the alkali-swelling factor is to be regarded as an enzyme of the cellulase complex, a curious experimental fact with which this belief must be reconciled is the observation that the growth on cotton fiber under suitable circumstances of certain Mucoraceous fungi causes an increase in the degree of alkali-swelling of the fiber. Among the fungi, the Mucorales as a group present a very unusual, if not unique, situation, in that numerous tests for action by members of the group on cellulose in various forms have all given results considered to be negative (9, 12, 13, 15). Nevertheless, when Circinella sydowi 9023, Cunninghamella 8985, Mucor hiemalis 8977a, Mortierella alpina 8979, and Zygorrhynchus 7935 were grown in shaking culture for five days in a mineral salts-0.2% glucose medium containing also 250 mg of raw cotton, the alkali-centrifuge values of the thus-incubated fiber increased to 318, 271, 310, 298, and 304, with a concomitant increase of microscopically-measured swollen fiber width to 34.1, 28.1, 34.3, 32.1, and 33.6 microns. A sterile-incubated control sample yielded an alkali-centrifuge value of 222 and a fiber width of 26.6 microns, these values being similar to those of un-incubated fiber. Filtrate from the culture of Mucor hiemalis was tested under sterile conditions on undamaged fiber for one week; it raised the swelling value of the fiber from 218 to 254, thus demonstrating low but definitely significant activity. These data actually are probably simply a reflection of the fact that the alkali-swelling response is tremendously more sensitive than the strength-loss response previously used as the principal criterion in establishing the non-cellulolytic nature of these organisms. It seems pertinent that sterile Myrothecium filtrates with an alkali-swelling activity of 130 or higher as exhibited in the usual one-hour exposure reduce the strength of unbleached duck by only about 30 percent in a week of exposure.

A dry commercial pectinolytic preparation, "Pectinol 100D" (Rohm and Haas), brought about striking increases in the alkali-centrifuge value of cotton. The manufacturer, however, stated that the preparation contained highly significant amounts of cellulase as an impurity, and this statement was checked experimentally in our laboratory. When strips of unbleached 8-oz. cotton duck were exposed for 14 days under sterile conditions to a water extract of the Pectinol sterilized by use of a Morton filter, a loss of 33 percent in breaking strength occurred. Attempts to obtain preparations active in the alkali-swelling test from various higher plants have to date been unsuccessful.

The relationship of the enzyme which affects the alkali-swelling of cotton to the cellulolytic enzymes "C_1" and "Cx" as described in recent publications by Reese and co-workers (8, 11, 12) has not been determined in this laboratory. Following the release of the alkali-centrifuge method to him by us in December of 1951, Reese has, however, made progress toward the solution of this problem[1]. It is recognized as a possibility that the agency in microbial filtrates which influences subsequent alkali-swelling of cotton fiber might consist of more than one active factor.

With undamaged fiber, the response observed in the alkali-centrifuge test is clearly related to wall thickness of the fiber as reflected in arealometer (6) air-flow measurements. Thin-walled fibers yield high results in both tests, in the former apparently as a result of the fact that with these fibers a greater lumen volume is available into which the cellulose may swell before encountering the limiting effect of the outer wall. In tests for deterioration on fiber samples of variable origin, it will probably prove necessary to use the arealometer test as a companion test to the alkali-centrifuge test in order that the results of the latter may be interpretable.

[1] Private communication from E. T. Reese.

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FUSARIUM WILT OF SESAME

Joanne K. Armstrong and G. M. Armstrong

A Fusarium wilt of sesame has been known to occur for some time in various parts of the world (4, 5, 6, 7, 8, 10, 12, 14), but it has been reported only recently in the United States (3, 9). In 1948, a typical wilt disease was found on sesame plants on a plantation in south Georgia. A foreman of the plantation thought that the disease probably had been present for at least 15 years.[1]

The wilt Fusarium was isolated from diseased plants, and single spore lines were used to inoculate a wide range of plants with methods previously described (1). The results of the inoculations of a few varieties and breeding lines of sesame are given in Table 1. The variety Sirogona was highly resistant; other varieties were less so or entirely susceptible. Inoculations were also made with other wilt fungi of recently proved pathogenicity, but none of the isolates mentioned below produced any wilt symptoms on sesame. In most cases, both the Criollo and P. I. 153508 varieties were inoculated with isolates of Fusarium causing wilt from the following hosts: alfalfa, bean, cabbage, carnation, Cassia tora L., cotton from United States, cotton from India, cotton from Egypt, cowpea races 1 and 2, crotalaria race 3, mimosa, okra, pea race 2, radish, soybean, spinach, sumac, tobacco, sweet potato, tomato race 1, and watermelon.

When the following plants were inoculated with the sesame-wilt fungus, no wilting occurred in any case: Kansas Common alfalfa; Mexican Pink and Kentucky Wonder beans; Copenhagen Market cabbage; Apollo carnation; Cassia; Golden Selfblanching celery; Rowden, Sakel, and Ashmouni cottons; Calva 7, Sumptuous, and Lady Finger cowpeas; kenaf; blue bitter lupine; mimosa (Albizzia julibrissin Duraz); Clemson Spineless okra; Thomas Laxton pea; Porto Rico sweet potato; Long White Icicle radish; Yelredo Soybean; Bloomsdale Savoy spinach; Ten-weeks bright pink stock; sumac (Rhus typhina L.); pure white sweet william; Gold Dollar and Burley 5 tobaccos; Bonny Best tomato; annual single mixed wallflower; and Garrison watermelon. Shaw (10) reported that the sesame-wilt Fusarium is nonpathogenic to Indian cotton and vice versa. Castellani (6) found that it is nonpathogenic to cotton and pepper.

Table 1. Results of inoculation of varieties and breeding lines of sesame with the sesame wilt Fusarium.

Varieties or breeding lines[a]	Number plants inoculated	Percentage of plants with external symptoms of wilt
Criollo	127	99.2
226	20	100
503	25	52
647	20	100
649	20	100
651	22	18
652	20	95
Sirogona	35	0
P. I. 153508	39	87

[a] Seed kindly furnished by J. A. Martin, Department of Horticulture, Clemson, South Carolina.

Butler (5) considered the sesame Fusarium to be a strain of F. vasinfectum Atk., and Terui (11, 12) also used this name for the fungus. Zaprometoff (14) accepted Butler's classification and called it F. vasinfectum var. sesami. Using the Snyder and Hansen system, Castellani (6) designated the organism as F. oxysporum forma sesami. There is abundant evidence in the literature that morphological and cultural characters are not satisfactory criteria for differentiating the members of the section Elegans. This was also evident when cultures of the sesame-wilt Fusarium were studied. Even though it cannot be differentiated from F. vasinfectum by these criteria, it is distinctly different in pathogenicity. Therefore, the names F. vasinfectum Atk. and F. vasinfectum var. sesami are misleading and should be discontinued. The writers have been investigating the host relationships of many of the wilt Fusaria for several years and have expressed the opinion "that not enough is now known about the host relationships of the numerous wilt Fusaria to attempt a mass revision on this bas-

[1] No wilt of sesame was found during a survey of sesame plantings in Georgetown, Berkeley, Charleston, and Colleton Counties, South Carolina, in the fall of 1949.

is" (2). There is an overlapping of hosts for some of these Fusaria, but the limited number of cross inoculations with the sesame Fusarium suggest that this form may be restricted in its pathogenicity to one host.

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U. S. BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING, DIVISION OF COTTON AND OTHER FIBER CROPS AND DISEASES IN COOPERATION WITH THE DEPARTMENT OF BOTANY AND BACTERIOLOGY, SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION. TECHNICAL CONTRIBUTION NO. 208, SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION.

PRELIMINARY HOST RANGE STUDIES WITH FUSARIUM OXYSPORUM F. CUBENSE

B. H. Waite and V. C. Dunlap

Investigations have been initiated to determine if various weeds and grasses found growing in banana plantings might act as carriers of the Panama wilt organism of bananas, Fusarium oxysporum f. cubense (E. F. Sm.) Snyder & Hansen. Past studies by Armstrong et al. (1) have revealed that some wilt Fusaria, pathogenically restricted to particular hosts, may be parasitic on other plants without a show of symptoms. In several cases they found slight internal discoloration but no external wilting was evident.

Procedure

In the current investigations, wild plants were collected from banana farms in which there has been an abundance of Panama wilt. After potting in sterilized sandy-loam, the plants became well established before inoculation. A culture of Fusarium oxysporum f. cubense, grown in a 10% by volume corn meal in sand mixture, was then used liberally to inoculate these plants. At least six weeks was allowed for contact between the roots and the fungus. When the roots were lifted, they were first thoroughly washed in tap water, then cut into small pieces, sterilized in a 1:1000 solution of mercuric chloride, and plated on a peptone-dextrose agar as described by Martin (2). Washing periods in mercuric chloride depended upon the type and thickness of the tissue and varied from 40 seconds to 4 minutes.

Observations

Of the many plants tested to date, three species of grasses and a low growing herb, Commelina diffusa Burm. (C. longicaulis Jacq.) have shown definite associations with the Panama wilt fungus.

Camalote grass, Paspalum fasciculatum Willd., is a heavy-growing stoloniferous perennial, widely distributed throughout tropical America especially along streams and in swamps. It is often found in and around banana plantations in Honduras, forming dense stands several meters in height unless periodically cut. F. cubense was isolated from stolons and roots after as long as four minutes sterilization in mercuric chloride. Colonies appeared most frequently at the stolon nodes and to a lesser extent from the smaller roots. In some instances a slight discoloration was observed within the stolons but such darkening could not be definitely correlated with the presence of Fusarium.

Para grass, Panicum purpurascens Raddi, a common tropical forage plant, is also a widely creeping grass with stolons that survive long periods under semi-aquatic conditions. As is true with camalote grass, old root parts are continually dying as new root tissue is produced. F. cubense was also isolated from Para grass stolons and roots. On several occasions the fungus was microscopically observed growing on thin cross sections of stolons that had been plated for several days on agar. Hyphae appeared to penetrate slightly only the outer cortex tissue. No hyphae were observed in vascular bundles.

Ixophorus unisetus (Presl.) Schlecht. also appears to be closely associated with the fungus, since colonies were occasionally obtained after several minutes' surface sterilization. This grass is an annual or biennial and forms heavy erect clumps which do not spread outward by means of stolons.

Commelina diffusa is commonly found as a low growing herb in the banana plantations. The wilt Fusarium was readily isolated from the nodes, from which roots penetrate into the soil, and from the cut ends of decumbent runners. Leaves in this species are borne sessile from the nodes. When cut in transverse sections with the leaf base still attached, the fungus was sometimes observed to grow from the cut leaf ends onto the agar. A yellowing of the vascular bundles was noticeable in some stem sections but could not be correlated definitely with the presence of the fungus. All sections with vascular discoloration did not necessarily produce Fusarium colonies on the agar.

Discussion

The isolation of Fusarium oxysporum from grasses in temperate regions has been reported by several workers. Sprague (3) lists a number of cereals and grasses on which the fungus is saprophytic or weakly parasitic. Similar affinities of Fusarium oxysporum f. cubense to

grasses and other plants growing in banana plantations may prove to be of some importance in the spread of the disease to bananas. Upon observance of the results in the pot grown plants, field collections of these species were made from areas immediately adjacent to diseased banana mats. In most instances the fungus was readily recovered. Studies are planned to determine the exact saprophytic or parasitic relationship with the associated plant species. As has been indicated, many of the grass roots are in various stages of health. While some areas of the roots are in active growth others are less active or actually in the process of dying. The pathogenicity of F. cubense in these hosts may, therefore, depend upon the particular conditions of the roots or stolons.

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CONTROL OF FIRE BLIGHT AND FROG-EYE LEAF SPOT (BLACK ROT) DISEASES OF APPLES IN DELAWARE IN 1952[1]

J. W. Heuberger and P. L. Poulos

For the past several years, the fire blight and frog-eye leaf spot (black rot) diseases have been increasing in severity on susceptible varieties in Delaware. This has been due to several factors: (a) environmental conditions favorable for fire blight infection and development; (b) lack of pruning of dead wood; and, (c) the advanced age of many of the trees. The severity of these two diseases has reached a point where control measures must be found or many orchards will be abandoned.

It has long been known that frog-eye leaf spot is correlated with fire blight, the causal organism (Physalospora abtusa) overwintering in the wood killed by fire blight (Erwinia amylovora) (1, 3). Such being the case, it is logical to assume that control of fire blight would aid markedly in control of frog-eye leaf spot.

Bordeaux mixture, applied during bloom, has long been the standard fungicide spray treatment for the control of fire blight. This treatment, although effective in more northern apple areas, has not been extensively adopted in Delaware because of its extreme phytotoxicity to the fruit. Recently (1952), Thomas and Henderson (4), working in Colorado, have shown that a dithiocarbamate fungicide (Dithane Z-78) when applied during bloom reduced blossom and twig infection by approximately 75 percent.

During 1952, a fungicide spray test was conducted in Delaware on the Starr variety (susceptible to both fire blight and frog-eye) to determine, primarily, if certain fungicide and antibiotic materials would control fire blight. Environmental conditions (six days of continuous rain) during the bloom period were extremely favorable for the development of both fire blight and frog-eye leaf spot and consequently both diseases became epiphytotic. Unfortunately, no fruit data was obtained as there was no set of fruit.

A preliminary report (2) has already been made on control of frog-eye leaf spot. It is the purpose of this paper to present final data on frog-eye control, in addition to that on control of fire blight.

Experimentation and Results

Three ethylene bis dithiocarbamate fungicides and several antibiotics were applied to single-tree plots, replicated four times and randomized. All of these materials were used as solutions or suspensions in water. Spraying was done with a power sprayer, at 500 pounds pressure, using a five-nozzle broom.

The first application was made on April 22 (full pink to early bloom stage). The next day, optimum conditions commenced for infection by the causal organisms of both the fire blight and frog-eye leaf spot diseases (rain fell almost continuously for the period April 23 to 29, inclusive, and totalled 3.33 inches). Subsequent spray applications were made on April 30 (about the end of full bloom), May 7 (late petal fall), May 19 (first cover), and June 4 (late second cover).

Fire blight control data were taken on May 16, 26, 29, June 10 and 23; frog-eye leaf spot control data were taken on May 9, 16, 26, 29, June 10 and 23. The trees were scored, for each disease, on the basis of 0 (no infection) to 10 (100 percent infection); these indices were then transformed to a percentage figure representing the average infection for the season. At each scoring date, the trees were examined also for indications of phytotoxicity. None was observed.

Complete data on materials, concentrations, and control are presented in Table 1.

The control data in Table 1 show the following:

1. The three ethylene bis dithiocarbamate fungicides (Dithane Z-78; Manzate; Parzate) gave significant control of both fire blight and frog-eye leaf spot.
2. The antibiotic Thiolutin, at 120 ppm., gave significant control of both diseases; however, it was much less effective than the three ethylene bis dithiocarbamate fungicides against frog-eye leaf spot.
3. The antibiotic Streptomycin sulfate, at all three concentrations used -- 120, 60, and 30 ppm., gave significant control of fire blight but was ineffective against frog-eye spot.

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Table 1. Apple fire blight and frog-eye leaf spot control, Starr variety, Bridgeville, Delaware, 1952.

Material[a]	Concentration (ppm)	Percent infection[c]	
		Fire blight	Frog-eye
Untreated		32	62
Thiolutin	120	16	35
	60	27	59
	30	17	56
Terramycin	120	24	55
	60	31	53
	30	33	74
Streptomycin sulfate	120	15	56
	60	16	55
	30	14	61
Copper rimodicin	120	30	50
	60	20	67
	30	32	60
Parzate	2400[b]	7	14
Dithane Z-78	2400[b]	15	17
Manzate	2400[b]	13	25
Raw thiolutin	120	25	54
	60	29	54
Raw terramycin	120	17	62
	60	29	57
L.S.D. @ 5% P.		16	15
L.S.D. @ 1% P.		22	20

[a] Before the test materials were applied, the entire block was sprayed with liquid lime sulfur (6 qts.-100) at the Pink stage.
[b] Equals rate of 2 lbs.-100 gallons of water.
[c] Fire blight was first observed on May 13; frog-eye on April 29.

As soon as it was observed that certain materials were giving control of frog-eye leaf spot, a block of bearing young Lodi trees in the same orchard was sprayed by the grower with Fermate (2-100), Dithane Z-78 (2-100), and Dithane D-14 plus ferric sulfate (2qts.-1 lb.-100) to obtain information on possible toxicity to fruit, if any; the antibiotic Thiolutin was not available in sufficient quantity for use in this work. Three applications were made: approximately at the late petal fall stage, first cover stage, and second cover stage. Examination of the fruit, at harvest, showed considerable russeting from Dithane D-14 plus ferric sulfate, some skin roughening from Fermate, and no injury from Dithane Z-78.

Summation

Control data, obtained under epiphytotic conditions during the 1952 growing season, indicate that two zinc ethylene bis dithiocarbamate fungicides (Dithane Z-78; Parzate) and manganese ethylene bis dithiocarbamate fungicide (Manzate) are highly effective in the control of both fire blight and frog-eye. Of these antibiotics, thiolutin (at 12 ppm.) gave significant con-

trol of both diseases; streptomycin sulfate (at 120, 60, and 30 ppm.) gave significant control of fire blight but failed to control frog-eye; and terramycin and copper rimocidin were ineffective against both diseases.

The data on fire blight control support those obtained by Thomas and Henderson in Colorado.

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DEPARTMENT OF PLANT PATHOLOGY, DELAWARE AGRICULTURAL EXPERIMENT STATION

CONTROL OF SUMMER DISEASES OF APPLE

G. D. Lewis and J. R. Shay[1]

During the past three seasons several minor apple diseases have caused severe fruit losses in southern Indiana orchards. In 1952, fair success was obtained for the first time in controlling these troubles on Golden Delicious without adverse affects on fruit finish. Although only one season's results are available, the writers believe the data warrant mention for possible use of other investigators faced with the problem of recommending summer fungicide schedules on Golden Delicious and other finish-sensitive varieties.

Black Pox: Black pox caused by Helminthosporium papulosum has become well-established in a young bearing orchard in Brown County, under good management but planted on an old orchard site. In this orchard, 12- 16-year old Gallia Beauty trees are in various stages of decline from pox lesions on twigs and scaffold branches. This variety appears to be particularly susceptible to wood infections. Several trees of another Rome strain, an attractive striped red sport, appear to be quite resistant to wood infections and are maintaining normal growth. Golden Delicious trees interplanted with the severely infected Gallia bear numerous pox lesions on limbs of all ages but the trees are not so adversely affected in vigor. The fruits of Gallia and Golden Delicious in this orchard have been unmarketable as a result of pox infections under reduced dosage sulfur spray programs. The standard sulfur dosages, generally used farther north for summer scab protection, are hazardous because of high temperatures. Excellent control of fruit lesions has frequently been obtained by the grower with weak Bordeaux cover sprays, but severe foliage injury occurred on both varieties and the Golden Delicious fruits were unmarketable due to severe russet.

Preliminary trials in 1951 in which 341, Dithane D-14 + ferric sulfate, Manzate, and wettable sulfur were applied in four cover sprays indicated that none of the materials were effective in the schedule used.

More extensive trials were conducted on Golden Delicious in 1952 comparing captan (formerly SR 406) in the form of Orthocide 406 with Tennessee Copper 26 and sulfur. The data in Table 1 summarize the results of these trials. All materials and schedules gave significant reduction in fruit pox but the captan schedules and the copper treatment were significantly better than sulfur. Although significant differences were not obtained among all the captan schedules, the data suggest that under the conditions of this test, the pink through fourth cover applications were more important in controlling fruit pox than later applications. All treatments gave good control of flyspeck (Leptothyrium pomi) and sooty blotch (Gloeodes pomigena), except sulfur which gave good control of flyspeck but poor control of sooty blotch. The copper sprays induced severe russet. The full season captan schedule resulted in the best finish of any treatment (Fig. 1). It is interesting to note that the omission of captan in the pink and calyx applications resulted in a significantly greater amount of russet than any other captan schedule. The foliage on the captan-sprayed trees was noticeably superior in size and greenness of leaves to any other treatment.

Botryosphaeria Fruit Rot: Growers in southwestern Indiana encountered extensive fruit rotting both before and following harvest in 1950 on several varieties, particularly Golden Delicious, Rome, Starking and Stayman. The rotting recurred in even more severe form as harvest approached in 1951. Fruits that appeared sound when harvested rotted rapidly when held at room temperature. In some cases the fruits rotted after packaging, sale, and delivery, and costly adjustments between grower and distributor had to be made. Botryosphaeria ribis was isolated repeatedly from infected fruits in 1951, and the typical rotting was obtained in artificial wound inoculation tests on mature fruits. Isolates of the black rot fungus Physalospora obtusa were included in the inoculation tests so that the type of rotting induced by the two fungi could be compared.

An extensive fungicide trial was conducted in a Gallia Beauty orchard at Vincennes in 1952 but the disease failed to develop. Fortunately, the disease was present in a nearby orchard in which Mr. D. H. Hamilton, entomologist of U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine, was conducting fruit finish experiments on Golden Delicious. Mr. Hamilton kindly allowed us to obtain data from his plots in which four fungicides had been

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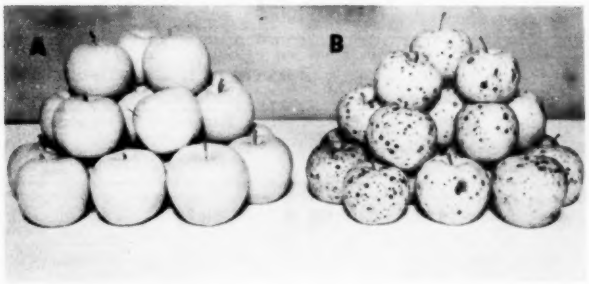

FIGURE 1. Fruits from Bessire Orchard spray trials. (A) fruits from tree receiving captan in pink through eighth cover spray. (B) fruits from check tree exhibiting black pox (Helminthosporium papulosum), sooty blotch (Gloeodes pomigena), flyspeck (Leptothyrium pomi), and Brook's spot (Mycosphaerella pomi).

FIGURE 2. Fruits of the second series from fungicide plots described in Table 2. At 1) are fruits from grower-sprayed orchard, 2) 341, 3) Captan 50 wettable, 4) Sulfur, 5) Standard Fungicide (Standard Oil Co. of Indiana). Fruits at A were photographed October 25 after removal from cold storage; fruits at B are the same fruits one month later.

Table 1. Effect of fungicides on disease development and finish on Golden Delicious apples. Bessire Orchard, Nashville, Indiana. 1952.

Treatment[a] Schedule	Number replications	Number fruits examined	Percent of fruits affected by disease or injury			
			Black pox	Russet	Flyspeck	Sooty blotch
Check[b]	4	1757	99.2	56.4	36.8	97.3
Sulfur						
Pink, calyx, 1-5[c]	4	1071	85.9	39.6	0.9	27.7
Ferbam						
Pink, calyx						
Tennessee copper						
1-6[d]	2	1000	2.8	95.3	0.0	0.0
Captan[e]						
Pink, calyx, 1-8	3	1500	6.5	17.3	0.0	0.0
Pink, calyx, 1-6	4	2000	8.7	33.7	0.0	0.0
Pink, calyx, 1-4	3	1500	16.1	42.3	0.0	0.1
1-6 (omit pink and calyx)	4	2000	20.0	63.4	0.0	0.1
Pink, calyx, 3-6 (omit 1, 2)	3	1500	27.1	39.4	0.3	0.3
Pink, calyx, 1, 2, 5, 6 (omit 3, 4)	2	1000	23.3	24.8	0.3	0.1

[a] Dates of application: Pink April 29, calyx May 6; first cover third week of May, second cover June 5, third June 19, fourth July 3, fifth July 17, sixth July 31, seventh August 14, eighth September 2. All plots received Aramite miticide in late June.

[b] No fungicide throughout season; received chlordane and DDT first week of August for apple curculio control.

[c] Pink: liquid lime sulfur 2 qt., Kolofog 3 lb./100 gal.
Calyx: Kolofog 3 lb., wettable sulfur 4 lb., lead arsenate 3 lb., lime 3 lb./100 gal.
First cover: Kolofog 3 lb., wettable sulfur 4 lb., DDT 50% 2 lb./100 gal.
Second and third covers: Kolofog 2 lb., wettable sulfur 2 lb., DDT 50% 2 lb./100 gal.
Fourth and fifth covers: Kolofog 3 lb., DDT 50% 2 lb./100 gal.

[d] Pink: Fermate 2 lb./100 gal.
Calyx: Fermate 2 lb., and lead arsenate, 2 lb./100 gal.
First through sixth covers: Tennessee copper 26, 2 lb., high Mg. lime 2 lb., and DDT 50%, 2 lb./100.

[e] All captan applications in pink and calyx were at rate of 2 lb. of 50% wettable powder /100 gal. Lead arsenate 2 lb./100 gal. added in calyx.
All captan cover sprays were at rate of 1 lb. of 50% wettable powder plus 2 lb. DDT 50%/100 gal.

used in calyx through seven covers. The last cover was applied August 18 and the fruits were harvested September 24. Samples of 50 fruits free from blemishes were collected at harvest from each treatment. The samples were each divided into two lots of 25 fruits. One lot was held at room temperature and the other placed in cold storage. After one month, the second lot from each treatment was removed from cold storage and placed at room temperature.

Table 2. Effect of fungicides on post harvest rot of Golden Delicious caused by Botryosphaeria ribis. Vincennes, Indiana. 1952. (Data obtained in cooperation with Don Hamilton U. S. Bureau of Entomology and Plant Quarantine.)

Treatments		Percent fruits rotted after 2 weeks	Percent fruits rotted after 1 month
Orchard No. 1[a]			
13. Captan - DDT	Series 1[b]	0	12
	Series 2	12	16
14. Standard Fungicide - DDT	Series 1	32	84
	Series 2	92	96
15. Crag 341 - DDT	Series 1	12	60
	Series 2	64	84
16. Sulfur - Lead Arsenate	Series 1	60	96
	Series 2	84	92
Orchard No. 2			
Grower's schedule[c]	Series 1	68	96
	Series 2	96	100

[a] Treatments 13-16 were U.S.D.A -- B.E.P.Q. plots of Mr. Don Hamilton as follows:

Treatment 13: Captan 50% 2 lb. in calyx and first to third covers, captan 50% 1 1/2 lbs. in fourth to sixth covers, captan 50% 1 lb. in seventh) cover applied August 18. All sprays contained 2 lb. DDT, 50% per 100 gal.

Treatment 14: Standard Fungicide 1/2 pt; DDT 50%, 2 lb./100 gal. in calyx through seven covers.

Treatment 15: Crag 341 1 1/2 qt., lime 2 oz. in calyx, Crag 341 1 qt., lime 2 oz. in first through seventh covers. All sprays contained 2 lb. DDT, 50% per 100 gal.

Treatment 16: Sulfur 5 lb., lead arsenate, 3 lb.; lime 3 lb. in calyx and first three covers; Kolofog 2 lb., lead arsenate 3 lb., lime 3 lb. in fourth through seventh covers.

[b] Fruits for both series collected September 24. Fruits in first series were placed at room temperature immediately. Fruits in second series retained in cold storage until October 25, then placed at room temperature.

[c] Postbloom fungicide applications in grower's schedule were Ferbam 1 1/2 lb./100 in calyx, first and second cover; Kolofog 1 lb./100 in third cover.

The data on fruit rotting from the four fungicide plots in the two series are presented in Table 2. Also included are data on fruits selected as free from blemishes from a nearby grower-sprayed orchard. Rotting was extensive in the fruits from the grower-sprayed orchard and in all plots except those receiving captan (Fig. 2). Since the final spray application was made 37 days before harvest, it is possible that B. ribis infections may take place during the summer and remain latent until the fruits approach or attain maturity. The financial loss to the grower occasioned by this disease can be tremendous.

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INOCULATIONS WITH UREDIOSPORES OF TRANZSCHELIA DISCOLOR (FCKL.) TRANZ. & LITV. FROM NORWAY

John C. Dunegan[1], Toralv Ramsfjell[2], and Halvor B. Gjaerum[3]

In 1938 the senior author[4] concluded, from his study of herbarium material, that the discolor variety of Tranzschelia pruni-spinosae, now called T. discolor, infects cultivated species of Prunus throughout the world. Such a conclusion implies that urediospores of T. discolor from one country or region should infect cultivated species of Prunus when introduced into other areas. In 1949 Goldsworthy and Dunegan[5] demonstrated that the urediospores of the rust fungus attacking peach trees in California can infect peach leaves in Maryland. These inoculation experiments proved that T. discolor in California is identical with the fungus occurring in eastern orchards.

Recently it has been possible to expand this inoculation program and test urediospores of T. discolor from Europe. On September 9, 1952, one of us (Gjaerum) collected T. discolor with urediospores and teliospores on the leaves of the St. Julien plum (Prunus insititia) in Rogaland in southwestern Norway. The urediospores were viable on September 18 when a portion of this collection was received at Beltsville, Maryland. Using the petri dish technique[6] in the laboratory as a precaution against the possible introduction into the United States of races of T. discolor of unknown potentialities, Dunegan immediately sowed some of the urediospores on leaves of peach and wild black cherry (P. serotina) floating on sugar solution.

The urediospores from this Norwegian collection infected peach leaves, producing urediospores in 18 days, but they did not infect the wild black cherry leaves. Previous inoculation experiments in the United States had demonstrated that the wild black cherry (P. serotina) is not a host for T. discolor. Accordingly, infection of peach leaves and the failure to infect wild black cherry leaves in the United States with urediospores from Norway prove that this collection of T. discolor is identical with T. discolor of the United States. As a further precaution all infected material produced by these inoculations was dried and preserved as herbarium specimens.

The St. Julien variety of plum is used extensively in Norway by nurserymen as rootstock for cultivated plums and prunes. The particular trees found to be rust-infected in Rogaland on September 9 were among a group imported from Belgium in the spring of 1952. Since T. discolor has not been observed previously in Norway it is presumed that the rust was introduced on these imported plants. The rust probably will not survive the winter in Norway, but additional observations will be made in 1953 to determine this.

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APHID MYZUS SOLANI DOES NOT TRANSMIT STRAWBERRY YELLOWS VIRUS COMPLEX

P. W. Miller

Plakidas (5), Massee (3, 4), Vaughan (7), Zeller and Vaughan (9) and others have shown that the strawberry aphid, Capitophorus fragariae Theob. (now called C. fragaefolii (Ckll.)) is a common vector of strawberry viruses. Demaree and Marcus (1) showed that C. minor (Forbes) and an unnamed species of Capitophorus are also common vectors in some areas. Whitehead and Wood (8) demonstrated that a closely related species Pentatrichopus tetrahodus Walk. can also transmit the crinkle virus complex.

Frazier (2) in 1951 reported that certain strawberry viruses in California are transmissible by five other species of aphids, namely, Macrosiphum pelargonii (Kalt.), Amphorophora rubi (Kalt.), Myzaphis rosarum (Walk.), Myzus ornatus (Laing.), and Myzus porosus (Sand). Three other species of aphids tested, namely Aphis forbesii Weed, Macrosiphum solanifolii (Ashmead), and Myzus solani (Kalt.), failed to transmit the viruses tested. Posnette (6) recently reported the transmission of two components of the strawberry virus complex by the aphids Myzus ascalonicus Doncaster and Acyrthosiphon malvoe subsp. rogersii (Theob.).

During the course of the writer's investigations on strawberry virus diseases, the aphid species Myzus solani (Kalt.) was found, on a number of occasions, colonizing on both wild and cultivated strawberries in the field. Although Frazier (2) tested this species for transmission of the crinkle complex, he does not report transmission tests with the yellows virus complex. To determine if this aphid can transmit the yellows virus complex, additional tests were carried on by the writer. In these tests, 5 aphids from a colony maintained for 10 days on a yellows-infected Marshall strawberry plant were transferred to each of 20 virus-sensitive, healthy Fragaria vesca plants and allowed to feed thereon for 5 days. None of these plants became infected; therefore, this aphid species does not appear to be a vector of the strawberry yellows virus complex.

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DIVISION OF FRUIT AND NUTS CROPS AND DISEASES, U. S. BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING, AND DEPARTMENT OF BOTANY AND PLANT PATHOLOGY, OREGON AGRICULTURAL EXPERIMENT STATION, CORVALLIS, OREGON

SUMMARY OF THE SEARCH FOR VIRUS-FREE PLANTS OF STRAWBERRY VARIETIES

C. P. Marcus, Jr. and P. W. Miller

An earlier review of the status of the virus situation in strawberries of eastern United States (PDR 35: 527-537. 1951) showed that nearly all plants there are infected. The present report summarizes progress to the end of the 1952 season in the search for virus-free plants. Included are a review of the status of the virus-free varieties obtained in previous years at Beltsville, Maryland, and a summary of the work in 1952 to the end of the growing season at Beltsville and at Corvallis, Oregon.

Beltsville, Maryland

Status Of Virus-free Varieties Obtained Prior To 1952: Virus-free plants were obtained in 1949 of 4 varieties -- Klondike, Klonmore, Tennessee Beauty, and Tennessee Shipper; in early 1950 of 8 varieties -- Blakemore (three stocks), Catskill, Corsican (? identity), Howard 17 (Premier) (two stocks), Massey, Sparkle, Tennessean, and an unidentified one (received as Howard 17 (Premier)); in late 1950 and early 1951 of 14 (possibly 15) varieties -- Albritton, Armore, Aroma, Beaver (probably Dunlap), Cheyenne 2, Cheyenne 3, Dunlap, Fairfax, Gem, Joe (Big Joe), Midland, Missionary, Robinson, Suwannee, and Vermilion; and in late 1951 of 3 varieties -- Konvoy, Marion Bell, and Sioux.

Virus-free stocks of the first 12 varieties went to cooperating nurseries for propagation in 1952. These nursery plantings were dusted at proper intervals and the surrounding wild plants were destroyed. In November, at the end of the growing season, plant samples were dug from the fields and index-grafting to Fragaria vesca to determine whether any spread of virus into the stock could be found was begun. No vector aphids were found in the fields at any time during the season.

In addition to the 29 varieties just listed, Royal Sovereign (received from England as virus-free) tested virus-free. Stocks of all the varieties are being propagated on the Plant Industry Station Farm at Beltsville.

Indexing In 1952: Plants of the 20 varieties listed in Table 1 were obtained from seven States and from one foreign country, Guatemala. Selected vigorous plants were sent in for indexing by cooperators.

Of the 209 grafts made, 28 percent (58) were virus-free and 72 percent (151) virus-infected. Virus-free plants of seven different varieties were found; of these five (possibly six) had not been found previously. These varieties and their sources are as follows: "Parramos" from Guatemala, Bellmar from Arkansas, Brilliant[1] from Michigan, "Golden Bell" (possibly Howard 17 (Premier)) from Pennsylvania, Redstar from Delaware, and William Belt from Pennsylvania.

In addition to the indexing for virus-free plants of varieties reported in Table 1, 188 index-grafts of 83 selections from North Carolina and 6 of a selection from Wyoming were made. Other indexing included a recheck of experimental virus-free plantings on the Plant Industry Station Farm, in West Virginia, and in North Carolina. Including the wild plant survey reported earlier (PDR 36: 353-354. 1952), 591 grafts were made in 1952. In Eastern States few vector aphids were present in most fields in 1952.

Corvallis, Oregon

In Oregon, 14 varieties and 97 selections, totaling 919 plants, were indexed from 1950 to 1952, mostly by grafting to Fragaria vesca (East Malling strain). Virus-free plants of the following varieties were obtained: Marshall, Northwest, Corvallis, Brightmore, Red Rich, Climax (received from Scotland as virus-free stock), and Magoon. No virus-free plants of the following varieties were found: Narcissa, Redheart, Clarke's Seedling, Royal Sovereign, and Tardlive de Leopold. Virus-free plants of 81 Oregon-US selections and 1 California selection were found. No healthy plants were found in 13 other Oregon-US selections and 2 other California selections. Of the Oregon-US selections, 100 percent of the 1950 selections, 90 percent

[1]Distribution limited under Plant Patent.

Table 1. Results of indexing strawberry varieties for virus in 1952, Beltsville.

Variety	Number of lots received	Number of grafts made	Number virus-free	Number virus-infected
Ambrosia	2	2	0	2
"Parramos"	1	8	5	3
Bellmar	1	9	9	0
Blakemore	1	6	1	5
Brilliant	1	5	4	1
Chesapeake	1	7	0	7
Dorsett	1	10	0	10
Fairland	2	16	0	16
Fairpeake	1	4	0	4
Gem	1	6	0	6
"Golden Bell"	2	24	23	1
Joe (Big Joe)	2	3	0	3
Late Giant	2	6	0	6
Mastodon	1	2	0	2
Missionary	1	4	0	4
Neet	1	5	0	5
Redstar	4	20	8	12
Temple	9	62	0	62
Tennessee Supreme	1	2	0	2
William Belt	1	8	8	0
Total	36	209	58	151

of the 1949 selections, and 81 percent of the 1948 selections were virus-free, whereas only 21 percent of the 1947 selections were healthy. Dusting with parathion for the control of the vector, the strawberry aphid, was begun in 1949 and has been carried on every year since. Apparently, with control of aphids, little if any virus spread has occurred.

Discussion And Summary

Up to now, virus-free plants have been found in varieties which comprise about 96 percent of the strawberry acreage in the United States. No virus-free plants of Aberdeen, Ambrosia, Chesapeake, Dorsett, Fairland, Fairpeake, Lupton, Mastodon, Pathfinder, Temple, and Redheart, nor of certain other varieties of less importance, have yet been obtained.

Virus-free plants of 29 varieties were obtained before 1952 and of 5 (possibly 6) more in 1952, in the Beltsville work. In Oregon, virus-free plants of 6 other varieties were obtained, making a total of 40 virus-free varieties at the present time. Imported virus-free Climax from Scotland and Royal Sovereign from England also tested virus-free. Indexing is now in progress in various States and will doubtless result in finding virus-free plants of additional varieties.

DIVISION OF FRUIT AND NUT CROPS AND DISEASES, U. S. BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING, BELTSVILLE, MARYLAND

A PROBABLE VECTOR OF ABUTILON MOSAIC ON SPECIES OF SIDA IN FLORIDA

A. S. Costa[1] and C. W. Bennett[2]

A mosaic of Sida rhombifolia L. and other species of the genus was reported from Florida by Kunkel (4). He was able to transmit the disease by grafting and pointed out that it resembled Abutilon mosaic.

In 1946, 1947, and again in 1952, the writers observed plants of the genus Sida in the vicinity of Orlando and in other parts of Florida affected by a disease that produces a conspicuous type of yellow mottle. This disease is probably the same as that studied by Kunkel, and its symptoms are closely similar to those shown by plants of species of Sida affected with a mosaic in the State of São Paulo, Brazil.

The occurrence of a mosaic on species of Sida in Florida seems of special significance because of the fact that studies by Silberschmidt (6) on mosaic of Sida and other malvaceous plants in Brazil have indicated that the Brazilian Sida mosaic is identical with "infectious chlorosis of Malvaceae" as described by Baur (1), and now commonly known as Abutilon mosaic.

Variegated plants of Abutilon striatum Dicks. and related species have been propagated and widely disseminated as ornamental shrubs. No evidence of natural spread has been reported in Europe or in the United States, and the agent responsible for the variegation has been cited by some investigators as an example of a virus that probably has no insect vector. However, Orlando and Silberschmidt (5) demonstrated that infectious chlorosis of Malvaceae is transmitted in Brazil by a white fly, Bemisia tabaci (Genn.). These results have been confirmed by the writers (2).

The observations on the occurrence of mosaic on species of Sida in various parts of Florida indicate that this disease is widespread in the State. A high percentage of infected plants is often found in natural stands of the weed. Seedlings, as well as older plants, may be affected. Often a plant may show evidence of disease only on the younger leaves, indicating that it was first healthy and later became infected. These observations constitute evidence of natural spread of the disease.

Although transmission of Abutilon mosaic virus through the seeds has been reported (3), it appears that mosaic of Sida in Florida (4), as well as in Brazil (5), is not transmitted through the seeds of Sida spp. It seems probable, therefore, that the mosaic of Sida in Florida is being spread from diseased to healthy plants by an insect vector.

From the results obtained in Brazil, it would be expected that the vector of mosaic on Sida in Florida would also be a white fly. Bemisia tabaci, the vector of Abutilon mosaic on Sida in Brazil, has not been reported from the United States previously, but a closely related species B. inconspicua (Quaintance), is known to occur in Florida.

Examination of diseased and healthy plants of Sida spp. in January 1952 by one of the authors disclosed the fact that one or more species of white fly occurred on both healthy and diseased plants in the vicinity of Orlando. Some of these insects were collected and sent to Miss Louise M. Russell, Division of Insect Identification, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, for identification. Certain specimens from this collection were considered by Miss Russell to be identical with specimens of Bemisia tabaci that she had received earlier from São Paulo, Brazil.

This evidence, although largely circumstantial, seems sufficiently strong to justify the tentative assumption that infectious chlorosis of Malvaceae, or Abutilon mosaic, is widely distributed in Florida on species of Sida and that it is being spread there under natural conditions by the known insect vector, Bemisia tabaci. The occurrence of B. tabaci in Florida has added significance because of the fact that this insect vector is the vector of a number of other viruses, none of which are known to occur at present in the United States. With the vector apparently well distributed in Florida, any one of these viruses could presumably become established if introduced.

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DIVISION OF SUGAR PLANT INVESTIGATIONS, U. S. BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING, RIVERSIDE, CALIFORNIA

NORTHERN CORN LEAF BLIGHT IN WISCONSIN IN 1952

Paul E. Hoppe

A report received the first week in September from Juneau County (south-central Wisconsin) that some corn fields in that area were drying prematurely from unknown causes was followed immediately by an investigation which disclosed the trouble to be northern leaf blight, caused by Helminthosporium turcicum Pass.

Severely infected fields in this area were conspicuous from the highway. In these the lower leaves were completely dried and the typical elongated lesions had developed even on the uppermost leaves of the plants. The ears were only in the milk stage of maturity at this time and it was apparent that material damage already had occurred. In most fields in the Juneau County area, however, the disease was much less severe and it seemed unlikely that silage quality or grain yields would be seriously affected. The heavier attacks appeared to be associated with certain hybrids.

Numerous other reports of severely damaged fields indicated that the blight area extended from Juneau County westward to the Mississippi River, and to the north and northwest from this general region. The disease was reported even at Spooner in the extreme northwestern part of the State.

Elsewhere in Wisconsin northern corn leaf blight could be found in almost all fields but not to such an extent as to attract general attention or cause much damage to the crop.

In the breeding fields, at Madison, leaf blight was most severe in inbred lines and wide differentials in their reactions were recorded. The level of disease was somewhat lower in the single-crosses and too low in the commercial and experimental double-cross hybrids for useful data on relative resistance.

Helminthosporium leaf blight has occurred in some areas of Wisconsin during recent years, but never before so severely nor so widely distributed as in 1952.

DIVISION OF CEREAL CROPS AND DISEASES, BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING, AGRICULTURAL RESEARCH ADMINISTRATION, U. S. DEPARTMENT OF AGRICULTURE, AND THE WISCONSIN AGRICULTURAL EXPERIMENT STATION

REACTION OF STRAINS OF RED CLOVER TO STEMPHYLIUM SARCINAEFORME

J. H. Graham

Stemphylium leaf spot (target spot) caused by Stemphylium sarcinaeforme (Cav.) Wiltshire is prevalent during late summer and fall in most years throughout the Eastern red clover region. In central Pennsylvania during 1950 and 1951 a high percentage of plants (90 percent in some fields) was diseased and many of the leaves killed. In 1952, however, little damage was noted, owing perhaps to the late summer drought.

A collection of 27 strains of red clover from various parts of the United States, Canada, and Europe was screened for possible sources of resistance[1]. The strains were compared in two or more tests consisting of 50 plants per strain, 10 plants in each of 5 replications. Seedlings were transplanted to soil in flats and inoculated at the 6-to-10 leaf stage by spraying a spore and mycelial suspension on the leaves. A mixture of isolates collected in central Pennsylvania was used as inoculum. After inoculation the plants were kept in a moisture chamber for 48 to 72 hours at 20° to 25° C. A rating system of 0 (free from disease) to 10 (all leaves killed) was used.

Table 1. Reaction of strains of red clover to Stemphylium sarcinaeforme.

Div. of Forage Crops No.	Strain	Origin	Rating
Farmers Strain	Wilson	Pennsylvania	2.8
Farmers Strain	Craig	Pennsylvania	2.8
F.C. 23400	Cert. Kenland	Kentucky	2.9
F.C. 23395	Pennscott	Pennsylvania	2.9
F.C. 23220	Northern Minnesota	Minnesota	3.3
F.C. 22821	Iowa	Iowa	3.5
F.C. 23191	Bashore	Pennsylvania	3.7
F.C. 23375	Cert. Cumberland	Kentucky, Tennessee, Virginia	3.9
F.C. 23373	Cert. Midland	Midwest	4.5
F.C. 23414	Rahn	Illinois	4.7
F.C. 22821	Emerson	Iowa	4.8
F.C. 23383	McConico	Alabama	4.8
	Purdue	Indiana	5.3
F.C. 13274	Wisconsin Mildew Resistant	Wisconsin	5.5
	Cotswold, Late Flowering	England	5.7
	Tammisto	Finland	5.7
PEI 141231	Dollard	Quebec	5.8
	Svalof	Sweden	6.0
PEI 148274	Ottawa	Ontario	6.1
F.C. 23419	Louisiana	Louisiana	6.4
	Frandsen 416	Denmark	6.4
	Ultuna	Sweden	6.7
	Merkur	Sweden	7.7
	Frandsen 415	Denmark	7.8
	Weibull's Resistant	Sweden	8.0
	Aberystwyth S-151 (Welsh)	England	8.1
F.C. 23217	Altaswede	Alberta	8.8

The average disease ratings of all tests are presented in Table 1. None of the strains

[1]The author is indebted to Dr. R. G. Hanson, formerly of the U. S. Regional Pasture Research Laboratory, for supplying most of the plant material.

was highly resistant to S. sarcinaeforme although a wide range in susceptibility was evident. In general, the strains were grouped according to the area of their origin. Three Pennsylvania varieties and Kenland were relatively resistant, while varieties originating farther west were more susceptible, and foreign strains (including some from Canada) were most susceptible. From 50 to 90 percent of the leaflets and petioles of the latter group were killed within nine days after inoculation. Two strains from the Gulf States were intermediate in susceptibility in relation to the other selections.

Generally the relatively resistant strains came from areas where the disease is most severe. Where the disease is prevalent in the East (including West Virginia and parts of Kentucky) some natural selection could be expected. Reports of disease surveys in the Midwest indicate that Stemphylium leaf spot is of less importance in most States though it may be moderately severe in some years. In Canada and the red clover areas of Europe where damage from the disease is less common little natural selection would have occurred.

Although no strain was highly resistant, differences in reaction among plants of locally adapted varieties suggest the possibility of isolating more resistant clones.

U. S. REGIONAL PASTURE RESEARCH LABORATORY, STATE COLLEGE, PENNSYLVANIA

THE REACTION OF ROWAN, KOREAN AND KOBE LESPEDEZA TO ROOT-KNOT NEMATODE SPECIES

J. C. Wells, Clarence H. Hanson, and J. Lewis Allison

In tests of annual lespedeza strains on root-knot nematode-infested soils in North Carolina one strain, F.C. 31480-43, later increased and released as Rowan lespedeza, was found to have resistance to root-knot nematodes (Meloidogyne spp.) (2). It is now possible to supplement that report with information on the reaction of Rowan to individual species of Meloidogyne.

Table 1. Relative susceptibility of Rowan, Korean and Kobe lespedeza to Meloidogyne species, based on the number of galls on the roots.

Species of Meloidogyne	Mean gall index[a]		
	Rowan	Korean	Kobe
M. arenaria	66.6	78.0	56.8
M. hapla[b]	95.8	95.8	81.2
M. javanica	71.4	75.0	71.0
M. incognita[b]	13.1	66.6	91.6
M. incognita var. acrita	14.7	90.2	81.2

[a] 0 = no galls, 100 = severely galled.
[b] Available for one test only. Indices for remaining species are means for three tests.

Single female cultures of Meloidogyne spp., furnished through the courtesy of J. N. Sasser of the Division of Nematology, Bureau of Plant Industry, Soils, and Agricultural Engineering, were increased on tomatoes. The infected tomato roots were cut into fine pieces with scissors and mixed with steamed soil in 4-inch pots. Lespedeza seeds were germinated in Petri dishes and seedlings were set in a sufficient number of pots to subject four pots of each lespedeza variety to each nematode species; each pot contained three seedlings. The first test was planted April 5. Repeat tests were started June 6 and August 11, 1952. Roots of individual plants were examined and scored for gall formation seven weeks after planting. At that time, galls on infected rootlets contained large numbers of females with egg masses.

Gall indices are presented in Table 1 for Rowan and two commercial checks, Korean and Kobe. These data indicate that Rowen has resistance to M. incognita and M. incognita var. acrita. It was not immune but a relatively high degree of resistance was indicated. Rowan was susceptible to M. arenaria, M. hapla, and M. javanica. Korean and Kobe were susceptible to all species tested.

The superiority of Rowan in tests on root-knot nematode soils at four widely separated locations in North Carolina (2) suggests that M. incognita was the predominating species encountered at those locations. This is consistent with Chitwood's observation (1) that M. incognita is the most common root-knot nematode in southern United States. In view of its resistance to this species, Rowan appears promising as a variety and as a source of resistance in a breeding program.

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NORTH CAROLINA STATE COLLEGE AND DIVISION OF FORAGE CROPS AND DISEASES, U. S. BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING, COOPERATING, RALEIGH, NORTH CAROLINA

FUNGI ISOLATED FROM SOYBEAN PLANTS AT STONEVILLE, MISSISSIPPI, IN 1951-52[1]

R. A. Kilpatrick and Howard W. Johnson

During the seasons of 1951 and 1952, the prevalence of fungi occurring on different parts of soybean plants collected in the vicinity of Stoneville, Mississippi, was determined by isolations. These were made from the following parts of plants at various stages of growth: hypocotyls, cotyledons, roots, stems, petioles, leaflets, peduncles, pods, perianth remnants, stigma and style remains, funiculi, and seeds (both threshed and while still within the pods). Mercuric chloride (1:1000) was used as a surface disinfectant followed by four rinses of sterile, distilled water. The tissues were then transferred aseptically to potato-dextrose agar. In some cases, tissues were not surface-sterilized but were placed in a moist chamber to induce sporulation. After 24 to 48 hours, a direct transfer of spores was made to plates of potato-dextrose-agar with a spear-headed needle and the cultures that developed were studied later. This method worked well with Corynespora cassiicola, Cercospora sojina, other Cercospora spp., Phomopsis sojae, and Colletotrichum spp.

Table 1 lists the fungi isolated from the vegetative parts of soybean plants. The fungi

Table 1. Fungi isolated from the vegetative parts of soybean plants at Stoneville, Mississippi, in 1951-52.

Fungus	Part of plant					
	Root	Hypocotyl	Cotyledon	Stem	Petiole	Leaflet
Alternaria spp.	X		X	X	X	X
Aspergillus niger				X		
Aspergillus sp.				X		
Cercospora sojina						X
Cercospora spp.			X	X	X	X
Cladosporium spp.	X		X	X	X	X
Colletotrichum spp.		X		X		X
Corynespora cassiicola				X	X	X
Curvularia spp.	X			X		X
Dendryphium sp.				X		
Fusarium oxysporum	X		X	X		X
Fusarium roseum			X			
Fusarium solani			X			
Helminthosporium sp.	X					
Phomopsis sojae			X	X	X	X
Phyllosticta spp.			X	X		X
Rhizoctonia solani	X		X			X
Rhizopus nigricans				X		X
Sclerotium bataticola	X			X		X
Sclerotium rolfsii	X	X		X		
Unidentified spp.	X			X		X

most frequently isolated (in order of prevalence) were: Alternaria spp., Cladosporium spp.,

[1] Journal article No. 301. Mississippi Agricultural Experiment Station.

Phomopsis sojae, Fusarium oxysporum, Cercospora spp., Colletotrichum spp., Corynespora cassiicola, Curvularia spp., Phyllosticta spp., Rhizoctonia solani, Sclerotium bataticola, Sclerotium rolfsii, Rhizopus nigricans, Aspergillus niger, Aspergillus sp., Cercospora sojina, Dendryphium sp., Fusarium roseum, Fusarium solani, Helminthosporium sp., and a number of unidentified species. It is interesting to note that S. bataticola and P. sojae were isolated from soybean leaves, as well as from the other parts of the plant where they occur more commonly. Of the fungi isolated from soybean stems, the following were obtained from material that overwintered out-of-doors; Cercospora spp., Colletotrichum spp., Corynespora cassiicola, Curvularia spp., Dendryphium sp., and Fusarium oxysporum.

Table 2. Fungi isolated from the reproductive parts of soybean plants at Stoneville, Mississippi, in 1951-52.

Fungus	Part of plant					
	Peduncle	Pod	Perianth remnant[a]	Stigma and style[a]	Funiculus	Seed
Alternaria spp.	X	X	X	X		X
Aspergillus niger		X		X		X
Aspergillus sp.	X	X		X		X
Cercospora sojina						X
Cercospora kikuchii						X
Cercospora spp.	X	X		X	X	
Chaetomium sp.						X
Cladosporium spp.	X	X	X	X		X
Corynespora cassiicola		X				X
Curvularia spp.		X		X		X
Fusarium oxysporum		X		X	X	X
Fusarium roseum						X
Fusarium solani						X
Nigrospora sp.						X
Penicillium spp.			X	X		X
Phomopsis sojae	X	X		X		X
Phyllosticta spp.	X			X		X
Rhizoctonia solani					X	
Rhizopus nigricans				X		X
Trichoderma sp.						X
Unidentified spp.	X	X	X			

[a] Adhering to tips of pods in various stages of maturity.

Table 2 lists the fungi isolated from the reproductive parts of soybean plants. These are (in order of prevalence): Alternaria spp., Cladosporium spp., Aspergillus spp., Cercospora spp., Fusarium oxysporum, Phomopsis sojae, Aspergillus niger, Curvularia spp., Penicillium spp., Phyllosticta spp., Corynespora cassiicola, Rhizopus nigricans, Cercospora sojina, Cercospora kikuchii, Chaetomium spp., Fusarium roseum, Fusarium solani, Nigrospora spp., Rhizoctonia solani, Trichoderma spp., and several unidentified species.

Of the fungi isolated from soybean seeds, two (Cercospora sojina and Corynespora cassiicola) were isolated from threshed seed only; six (Chaetomium spp., Fusarium roseum, Fusarium solani, Nigrospora spp., Rhizopus nigricans, and Trichoderma spp.) were isolated only from seed still within the pods; while the remaining species were isolated from both types of

seed. It is of interest that so many different fungi were isolated from soybean seeds removed aseptically from surface-sterilized pods. In attempting to explore how these fungi grew on or in the seed inside the unopened pods, isolations were made from funiculi and from floral remnants adhering to the tips of pods. While numerous fungi were isolated from these parts, particularly from the style and stigma which adhere to form a spine at the pod tip, there was no conclusive evidence as to how they gained entrance into the pod.

These studies show that a variety of fungi occur on soybeans in the Mississippi Delta. Several are the causal agents of serious diseases, while others are secondary invaders and of little or no economic importance at the present time.

DELTA BRANCH EXPERIMENT STATION, STONEVILLE, MISSISSIPPI. COOPERATIVE AGREEMENT BETWEEN THE DIVISION OF FORAGE CROPS AND DISEASES, U. S. BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING, AND THE MISSISSIPPI AGRICULTURAL EXPERIMENT STATION

RODENT FEEDING ON MYCELIAL PADS OF THE OAK WILT FUNGUS

Eugene B. Himelick, Richard D. Schein, and E. A. Curl

The oak wilt fungus, Endoconidiophora fagacearum Bretz, produces its conidial and ascigerous stages in mats between the bark and wood of infected trees of the red oak group. It also produced succulent pads or cushions in the centers of most of these mats. Vertical cracks develop in the bark directly outside the fructifications. These cracks expose the fructifications and provide portals through which spores and insects may enter and escape.

The method by which the fungus spreads beyond root graft distance is unknown. Workers at various stations are studying insects and at least one station is studying birds of the woodpecker family, to determine if they act as carriers. Feeding by rodents, probably gray squirrels, on mycelial mats is reported by C. L. Morris and C. L. Fergus to have occurred in Pennsylvania.

In the course of observational studies made during the winter of 1952-53 at several widely separated locations in Illinois, damage of the kind briefly described by Morris and Fergus was noted. Small areas of bark directly outside the fungus pads were completely torn away (Fig. 1, A and B), leaving irregularly shaped holes that exposed the pads. The pads were eaten away and scrape marks were visible on the wood beneath (Fig. 1, C and D). This damage differed markedly from that inflicted by woodpeckers. Only the pads were eaten; in no case was the surrounding mat damaged to any great extent. Upon close examination of the bark surrounding the holes, paired marks made during the cutting away of the bark were seen (Fig. 1, E and F). These marks were very much like those that would be made by the two upper incisor teeth of a rodent.

To determine the extensiveness of this damage to wilted oaks and the associated fungus pads, a survey was made of four major oak wilt areas in northern and central Illinois: the Cook County Forest Preserve District, Sinnissippi Forest at Oregon, a fifty-acre black and red oak forest near Byron, and a similar area near Easton. Trees of the red oak group known to have wilted in 1952 were examined. The holes were found at heights of 4 to over 40 feet. Other results of the survey are presented in Table 1.

Table 1. Rodent damage observed on wilt-killed red and black oak trees in four forests in Illinois in December, 1952, and January, 1953.

Forest	Number of trees killed by wilt in 1952	Number of trees producing mats	Trees showing rodent damage: Number	Number of holes on individual trees	DBH range (inches)	DBH average (inches)
Cook County Forest Preserve	4	3	3	1-6	20-26	23
Sinnissippi Forest	90	12[a]	10	1-27	3-16	11
Byron Forest	8	3[a]	2	2-12	15-21	18
Easton Forest	3	1	1	3	28	28

[a] One of the undamaged trees at Sinnissippi and the one undamaged tree at Byron were felled early in the fall, before rodent damage was observed on any standing tree.

One mat-bearing tree in the Byron forest was felled in early fall, before damage was observed on any standing tree. Although this tree is still producing fresh mats, it does not have

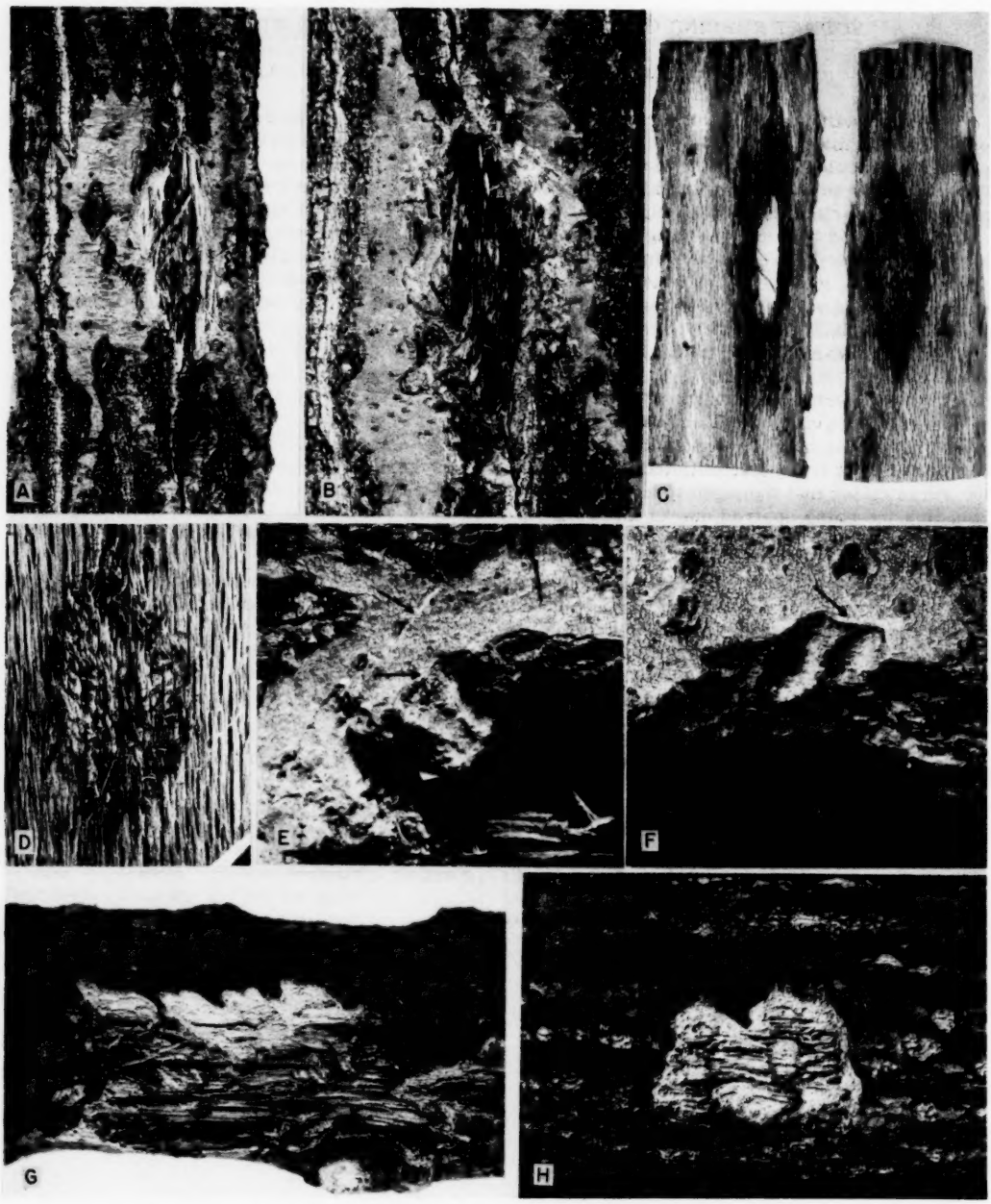


FIGURE 1. OAK BARK WITH CRACKS AND MYCELIAL MATS OF THE OAK WILT FUNGUS SHOWING RODENT FEEDING. A AND B. AREAS OF BARK SHOWING SHREDDED HOLES OVER MYCELIAL MATS. C. MYCELIAL MAT WITH BARK TURNED BACK TO SHOW PAD EATEN AWAY. D. CLOSE UP OF A MYCELIAL MAT SHOWING SCRAPE MARKS ON WOOD. E AND F. ARROWS INDICATE PAIRED INCISOR MARKS WHERE THE RODENT CHEWED AWAY THE BARK, MAGNIFIED. G AND H. HOW RODENTS CHEW BARK FROM BRANCHES OF HEALTHY BLACK OAKS; INCISOR MARKS ARE CONSPICUOUS.

rodent damage. Another mat-bearing tree, in the Sinnissippi forest, was felled in the early fall and most of its bark was removed in the process of looking for mats. This tree and another small uncut tree in Sinnissippi Forest with a small number of mats still remain untouched by rodents.

The fungus pads were eaten away on every tree on which the damage was noted. If the damage was inflicted by a rodent, as the case appears to be, it was possibly done in order to reach the succulent fungus pads. Cracks were present in most places where feeding was done and there was little random chewing. This suggests that the rodents were attracted to the cracks by the odor of the pads.

In an attempt to identify tentatively the kind of rodent responsible, until such time as perpetration of the damage is actually observed, measurements were made of the pairs of marks near the holes. These marks measured approximately 3-4 mm in breadth. Of the rodents present in Illinois, squirrels have incisor teeth most closely approaching this size. Five kinds of squirrels are found in the State. Most common is the western fox squirrel, Sciurus niger rufiventer; the breadth of its upper incisor pair of teeth is 3.5-4.0 mm. Next most common are the southern gray squirrel, S. carolinensis carolinensis, and the northern gray squirrel, S. carolinensis leucotis. The breadth of the upper incisor pairs in these animals is approximately 3-3.5 mm. Also present in the State are the flying squirrel. Glaucomys volans volans, and the rare red squirrel, Tamiasciurus hudsonicus loquax, both of which have much smaller teeth.

Although actual infliction of the damage has not been seen, several factors implicate squirrels. The sizes of the tooth marks around the holes correspond closely to the sizes of the incisors of fox and gray squirrels. Hairs resembling those of the gray squirrel were found in the frayed bark surrounding some holes. In addition, squirrels are very common in oak forests in Illinois and have been reported to eat fungi.

Damage to healthy oaks, believed to have been inflicted by squirrels, has been observed to be extensive. Rodent damage on branches of black oaks from which bark has been eaten is shown in Fig. 1, G. and H. It is known that squirrels gnaw bark around knots on trunks, eat bark from branches, and may occasionally girdle a sapling. During the spring of the year, buds and flowers of oaks are among their main foods.

Mats exposed to rodent damage were producing perithecia and an abundance of conidia. It seems possible that rodents feeding on mats could become contaminated with the fungus and transfer it when feeding on healthy oaks. Observational and experimental studies are under way to determine the agent of the damage and whether this agent can transfer the pathogen from diseased to healthy oaks with ensuing development of oak wilt symptoms.

SECTION OF APPLIED BOTANY AND PLANT PATHOLOGY, ILLINOIS STATE NATURAL HISTORY SURVEY, URBANA, ILLINOIS

OAK WILT: ITS DISTRIBUTION AND CONTROL

Marvin E. Fowler

About a decade ago a group of pathologists in Wisconsin proved a dying of oaks to be caused by the fungus Chalara quercina, now named Endoconidiophora fagacearum. At that time the disease, called oak wilt, was known in Wisconsin, Iowa, and Minnesota. The disease killed trees of the red oak group rapidly. By 1949 oak wilt had been found also in Missouri, Illinois, and Indiana. The discovery of oak wilt on the edge of the Ozark forests in southern Missouri in 1949 caused great concern and led to the initiation of surveys for the disease in 1950. These surveys, conducted by the Federal Government, with funds provided by the Forest Pest Control Act, and by various State agencies, the Tennessee Valley Authority, foresters, and a number of oak-using industries, have resulted in the finding of oak wilt in five States in 1950, in addition to the six in which the disease was previously known, and in seven more in 1951. The disease was not found in any additional States during 1952 but it was found in a number of additional counties in most of the States where it was previously known. Figure 1 shows the counties in which oak wilt was confirmed by cultures before 1950, during 1950 and 1951, and in 1952.

The Division of Forest Pathology of the U. S. Department of Agriculture assembles information on oak wilt surveys and control practices and disseminates this to interested parties. Various State agencies have supplied information regarding their work on the oak wilt problem, making it possible to prepare this comprehensive report.

The presence of oak wilt in 18 States, the rapidity with which trees in the red oak group succumb, and the losses that have already occurred in some places justify a consideration of this disease as a major threat to our forest economy. Pathologists, foresters, timberland owners, and oak-using industries are concerned for the safety of our valuable oak forests, and numerous property owners fear that they may lose their prized shade and ornamental oaks.

Symptoms Of The Disease

Oak wilt produces very noticeable leaf symptoms on trees in the red oak group. Early symptoms are usually limited to a wilting and bronzing of the foliage in the upper crown, followed by wilting and bronzing of the foliage throughout the crown, beginning at the ends of lateral branches. The bronzing of leaves usually begins at the apex and lobes of the leaf blade, spreading to the midrib until the entire leaf blade is involved. Defoliation usually accompanies these foliar symptoms, and affected leaves in any stage, including those that are fully green, may fall from the tree. Sprouting along the trunk and larger branches frequently occurs before an infected tree dies. In some cases when a tree dies very rapidly, very little defoliation occurs, but usually it is severe. Blackened longitudinal streaks sometimes occur in the sapwood of branches and main stem, but the causal fungus can be cultured from clear wood as well as from discolored; streaks in the wood are not a definite diagnostic symptom.

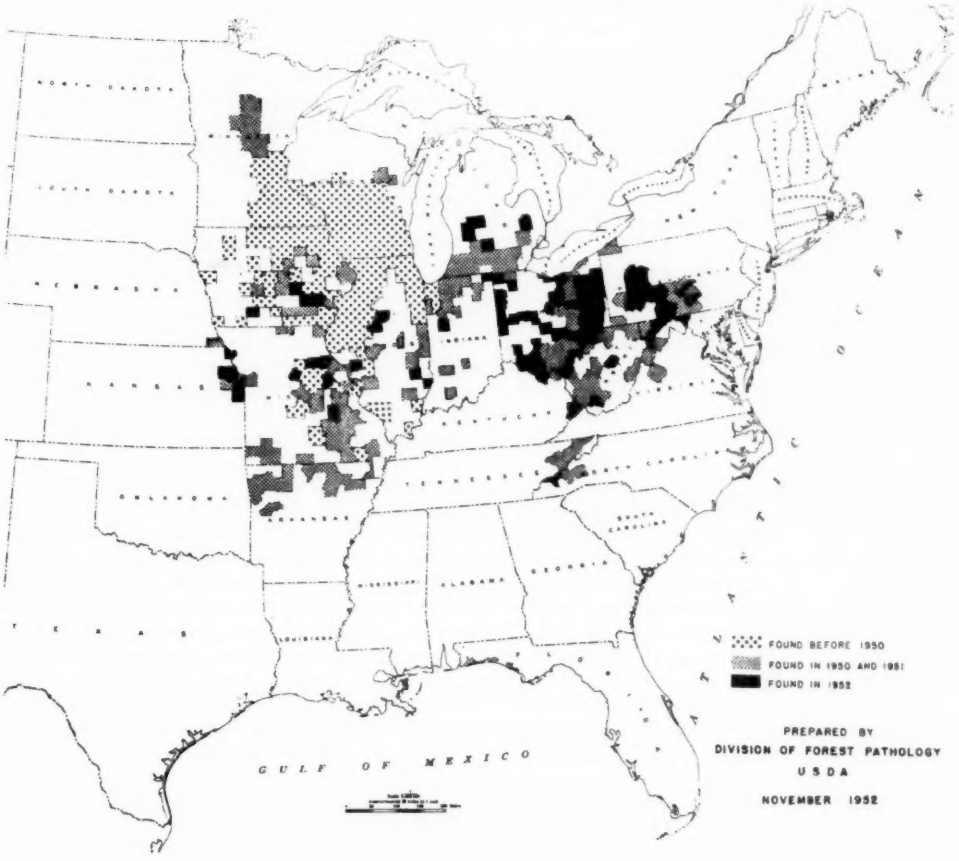
The wilt develops more slowly on trees in the white than in the red oak group. Frequently only one or a few branches of a white oak die in a year, but the disease usually persists, killing additional branches annually until the entire tree dies. The failure of oak wilt to develop rapidly on trees in the white oak group presents a serious problem in scouting for the disease; the symptoms sometimes are evident on only a single branch and may be concealed from view by surrounding healthy branches.

No native oak species is known to be immune from oak wilt. About 35 oak species are known to be susceptible, either by natural or experimental infections. Oak wilt has also killed a number of Chinese chestnuts in a plantation in Missouri. Inoculations indicate that the American and the European chestnuts, bush chinquapin, and California tanbark oak are susceptible to oak wilt. Trees of all ages and sizes and with varying degrees of vigor appear to be equally susceptible to this disease.

Oak Wilt Surveys

When the survey for oak wilt was initiated in the summer of 1950, it was found that preliminary scouting for the disease could be done successfully from low-flying airplanes. Healthy and diseased oaks are readily distinguished in a forest stand, even from a considerable distance. Many trees with foliar symptoms of oak wilt on only the uppermost branches can be distinguished more easily from the air than from the ground. In a relatively low-speed (70-plus miles per hour air speed) airplane at 200 to 500 feet above the tree tops, a competent observer can locate

FIGURE 1.
DISTRIBUTION OF OAK WILT IN THE UNITED STATES



oaks with discolored foliage for a distance of a quarter to a half mile. Airplane scouting for oak wilt has proved to be satisfactory, fast, and economical. Although the disease cannot always be definitely identified from the air, areas that do not contain wilted trees can be determined. Ground crews need only to check the suspected trees observed from the air and indicated on maps. From a high vantage point with the aid of strong binoculars, oak wilt can sometimes be seen from the ground for a great distance, but usually it would be necessary to make an almost 100 percent ground cruise of a dense forest to find scattered wilted trees that could be seen at a glance for one quarter mile or more from a low-flying plane. Two observers in an airplane, with a third man to handle maps and record tree locations in relation to nearby landmarks, can survey approximately 32 square miles (20,480 acres) of forest land in an hour. It would require several months for the same number of men to cruise such an area thoroughly on the ground.

Trees affected by oak wilt can usually, but not always, be distinguished from oaks dying from other causes. In areas where the disease has not been found previously it is advisable to examine trees closely from the ground; to be certain of the diagnosis the causal fungus must be cultured from specimens collected.

Green or recently dead wood that has not completely dried out is satisfactory for culturing. Twig or branch specimens, 6 to 8 inches long and 1/2 to 1 inch in diameter, should be collected

from about six places on the tree. Specimens must not be allowed to overheat or dry out, and must be cultured promptly for best results in isolating the fungus. In 1952 a number of workers reported that they were not entirely satisfied with the results of attempts to culture the fungus from specimens.

The increase in the known range of oak wilt does not in itself furnish information regarding the yearly spread of the disease. However, in many areas estimates have been made of the age of the oldest oak wilt infection found in each county. The disease has been present in Wisconsin, Iowa, and Minnesota for 20 years or more. In northwestern Indiana some infections appear to be at least 20 years or more old. Possibly some of the infections in northern Illinois and Missouri are as old. In both the Ozark area and in the East a number of infections appear to be from eight to ten years old, but the majority of infections examined are judged to be less than five years old.

Evidence now available suggests that oak wilt was disseminated to widely separated and distant points about eight to ten years ago. The most extensive movement of the disease appears to have been southward and eastward. The development of so many additional infection centers during the past five years indicates that conditions have favored a further buildup of the disease.

During the summer of 1952 the U. S. Division of Forest Pathology had four three-man oak wilt survey crews in the field, one in southern Missouri and in Arkansas, another in Kentucky and Tennessee, a third in the Appalachians and adjacent areas from Virginia to Georgia, and the fourth crew conducted surveys in the New England States and cooperated with State agencies in Pennsylvania, New York, New Jersey, and Maryland. In all of these areas close cooperation was maintained with the State agencies and local foresters. The Forest Service and the Bureau of Entomology and Plant Quarantine of the U. S. Department of Agriculture cooperated in the surveys in many areas.

Missouri: The State Agricultural Experiment Station cooperated with the U. S. Division of Forest Pathology in an aerial and ground survey in the southern part of the State in 1952. Oak wilt was not found in additional counties in that area, but specimens collected from trees in five other counties elsewhere in the State yielded the oak wilt fungus in culture.

Arkansas: The U. S. Division of Forest Pathology conducted an aerial and ground survey in 1952. Approximately 10 percent of the forests were inspected in the northern half of the State and a lower percentage in the southern half. The State Forest and Park Commission cooperated in this survey by providing airplanes for much of the work. The wilt was not found in any additional counties in 1952.

Kentucky: The Division of Forestry of the State Department of Conservation conducted some roadside and ground surveys for oak wilt in 1952. The Federal Government made an aerial survey over other parts of the State. Oak wilt was found in two additional counties during the year.

Tennessee: Both the Tennessee Valley Authority and the Division of Forestry of the State Department of Conservation conducted surveys for oak wilt in part of the State. The Federal Government conducted an aerial and ground survey in other parts of the State. The wilt was not found in any additional counties.

South Carolina and Georgia: The U. S. Division of Forest Pathology conducted limited aerial and ground surveys in the northern parts of these two States. Various State agencies cooperated. Oak wilt was not found in either State.

North Carolina: The Division of Forestry of the State Department of Conservation and Development conducted a survey for oak wilt in a number of counties and actively cooperated with the Federal Government in an aerial and ground survey in the western part of the State. Oak wilt was found in one additional county in 1952.

Virginia: The U. S. Division of Forest Pathology conducted a limited aerial and ground survey in west central Virginia in 1952, but found no oak wilt.

New York: The Division of Lands and Forests of the State Conservation Department surveyed for oak wilt from airplanes and on the ground, particularly in the southern parts of the State. The Federal Government assisted in part of the aerial work. Several trees with oak-wilt-like symptoms were observed from the air but the oak wilt fungus could not be cultured from any of the trees from which specimens were collected.

New Jersey: The Division of Plant Industry of the State Department of Agriculture, the State Department of Conservation and Economic Development, and the Department of Plant Pathology of Rutgers University cooperated in conducting an aerial and ground survey. The Federal Government assisted in the aerial work. Oak wilt was not found in the State.

New England States: State agencies cooperated fully in the somewhat limited aerial surveys conducted by the Federal Government. Oak wilt has not been found in these States as yet.

Pennsylvania: The Bureau of Plant Industry of the State Department of Agriculture, with the active cooperation of the State Department of Forests and Waters, Pennsylvania State College, and the State Game Commission, conducted an intensive survey for oak wilt throughout a large proportion of the more valuable oak forests in the State. The U. S. Division of Forest Pathology assisted in organizing the aerial survey. Oak wilt was found in eleven additional counties in 1952.

Maryland: The University of Maryland and the Department of State Forests and Parks cooperated in conducting an intensive aerial and ground survey for oak wilt in the three western counties in the State. The U. S. Division of Forest Pathology assisted in the aerial survey. Oak wilt was found in the westernmost county in 1951 and this year was found to be prevalent both there and in the other two counties. A less intensive survey was made in the next two counties to the east, but no additional oak wilt was found.

West Virginia: The Department of Plant Pathology and Bacteriology of the University of West Virginia, in cooperation with the State Conservation Commission and the State Department of Agriculture, again surveyed a part of the State, using airplanes and ground crews. In 1952 oak wilt was found in five counties in addition to the 17 in which the disease was previously known.

Ohio: The Division of Forestry of the State Department of Natural Resources, in cooperation with the State Agricultural Experiment Station, conducted an aerial survey for oak wilt in 85 of the 88 counties in the State. Oak wilt was found in 44 additional counties in 1952, making a total of 58 counties in Ohio in which the disease is known.

Indiana: State agencies conducted some surveys in the northeastern and southeastern sections of the State last summer. Oak wilt was confirmed from two additional counties during 1952.

Michigan: The Department of Botany and Plant Pathology of Michigan State College, the State Conservation Department, and the State Department of Agriculture extended their aerial survey for oak wilt farther north in 1952. The third and fourth tier of counties from the southern boundary of the State were surveyed and oak wilt was found in four additional counties.

Illinois: No formal survey was conducted for oak wilt in 1952. The disease is already known to occur in many parts of the State. During the year specimens cultured by the Section of Applied Botany and Plant Pathology of the State Natural History Survey Division confirmed oak wilt in five additional counties. The Forest Preserve District of Cook County again made its annual survey of its forested area from a helicopter as an essential part of an oak wilt control program.

Wisconsin: No attempt was made to survey the State in detail. For a number of years oak wilt has been known throughout the southern half of the State. Surveys in Wisconsin are being made by University officials only incidentally to their research investigations on oak wilt.

Iowa: Although no organized survey was conducted in 1952, pathologists of the Department of Botany and Plant Pathology of Iowa State College cultured the oak wilt fungus from specimens collected in four counties where the disease was not previously known.

Minnesota: The Division of Plant Pathology and Botany of the University of Minnesota reported that a search for oak wilt was made from airplanes in the northern half of the State in conjunction with a survey for forest insects. They did not find the disease in any additional counties.

Nebraska: A limited ground survey was made in southeastern Nebraska by officials of the State Agricultural Experiment Station. A few oaks in Nemaha County were seen with oak-wilt-like symptoms, but in the absence of confirmation by cultures, these cannot be definitely diagnosed as oak wilt.

Kansas: Through the cooperation of the State Agricultural Experiment Station, the Department of Botany of Kansas University, and the Kansas State Entomological Association, an aerial survey was conducted for oak wilt in the two eastern tiers of counties in 1952. The disease was confirmed by cultures from five counties in addition to the two in which it was previously known.

Damage And Control

No one can now accurately predict how much damage may be caused by oak wilt in the immediate future, or during the much longer period required for our younger oak forests to grow to maturity. An appraisal of the losses in the older infected areas may indicate what can be expected at other places, although nothing is now known about the possible effects that different growing conditions and climates may have on the disease.

Oak wilt has caused considerable damage in many oak wood lots in Wisconsin and Iowa. In some areas of from a few to 80 or 100 acres the mortality from oak wilt is 50 percent or more. In red oaks the wilt kills the stump and roots, and stump sprouting cannot take place. The local spread of oak wilt from tree to tree through natural root grafts, killing root systems and preventing stump sprouting, usually results in death of all oaks in the area. In mixed forest stands, other species are released; in pure stands an almost treeless area results until other species seed in from the outside.

The threat of oak wilt is very real. The disease is already known over a very large area, and, if left unchecked, may eventually spread over the entire eastern half of the United States. Losses would be tremendous if the disease should spread through the valuable oak forests of the Ozarks, lower Mississippi Valley, and the East as it has through some of the wood lots in Wisconsin and Iowa during the past 20 or more years.

Our present knowledge of oak wilt, the slowness of local spread of the disease, and the apparent absence of an efficient means by which the disease can make numerous and rapid jumps overland lend encouragement to the view that the disease can be controlled. It appears that a vigorous and continuous program can bring the wilt under control in forests in any given area and eliminate new infections as they appear. Control efforts can suppress the disease and reduce losses but probably will not completely eradicate the disease.

Recently the oak wilt fungus has been found to fruit in nature on wilt-killed trees. In some trees, following death, fungus mats form under the bark. These push against the bark and may crack or split it. The reasons for such fruiting on some trees and not on others are not known, nor is it known what part these fruiting structures may play in the long-distance spread of oak wilt. Insects and birds, and possibly rodents, are suspected of being capable of carrying spores from these fruiting structures to healthy trees, but no direct evidence of such dissemination is available.

The best control that can be recommended now is to destroy the oak wilt-infected trees to remove them as hazards in the spread of the disease. This may be accomplished by cutting and prompt burning or utilization of diseased trees. Removing the bark from the trunk and larger branches probably will prevent the fruiting of the fungus and may later be found to be effective in control efforts. If diseased oaks are cut into lumber, the slabs should be burned.

The oak wilt fungus has not been found fruiting on trees after they have been dead for two or three years and the bark has fallen from the tree. Such trees probably have ceased to be hazards for spread of the disease.

Lumber with bark and outer wood removed in slabs is not considered a hazard for spread of oak wilt. The ability of the fungus to fruit under the bark makes it unwise to utilize oak-wilted trees with bark attached for mine props, posts, railroad ties, or other products as they might serve to spread the disease.

About half of the infection centers under observation have enlarged through local spread; in others a single tree has been killed with no further local spread in subsequent years. The underground spread of oak wilt from tree to tree through root grafts has been stopped by poisoning all healthy oaks within about 50 feet of the diseased trees. In suppressing oak wilt either the surrounding healthy trees should be poisoned or the area should be inspected early in the following summer and annually for several years to determine if additional trees have become diseased. In forest stands it is usually more economical to poison the surrounding trees at once than to inspect again for subsequent infections and treat these and the surrounding ones.

Much research has been conducted on oak wilt but much more remains to be done. It is of primary importance to determine how the disease spreads a considerable distance from an infected tree to a healthy tree. This knowledge may provide a basis for the development of better control measures. Our present knowledge of the disease and its occurrence indicates two general conditions that must be considered in initiating a control program.

(1) In areas where oak wilt has been present for the greatest length of time, the disease is well established, many infection centers are large, and a suppression program would be very costly. The oak values in some of these areas are not high and in some wood lots the cost of eradicating diseased trees might exceed the value of the remaining trees. In many other wood lots the oak values are higher and a control program might be justifiable. The State of Minnesota is testing control measures on an experimental basis in three areas, involving about 5,000 acres of heavily infected oak forests. It is hoped that the results of their work may serve as a guide to adjacent States, and determine the practicability of arresting the spread of the disease under similar conditions.

(2) In the Ozarks and throughout the East, the situation is quite different. There the percentage of diseased trees is small and oak values are much higher. The cost of eradicating all

of the oak-wilted trees would be insignificant in comparison with the value of the residual oak forests. A disease suppression program could be justified on a unit basis. The units might consist of a distinct forest area, individual counties, or better still, an entire State or group of adjacent States.

Some States have already initiated oak wilt control programs and others are considering doing so in the near future. In Michigan, property owners are being asked to destroy all oak-wilted trees. Oak wilt has been found in 58 counties in Ohio, and the State is endeavoring to eradicate all of the diseased trees. Pennsylvania is conducting a vigorous control program, and Maryland is eradicating oak-wilted trees in its three western counties. West Virginia is testing control measures in some counties, and is attempting to eradicate the disease in other parts of the State. Kansas is destroying all oak-wilted trees. The only oak-wilted tree found in Virginia was destroyed in 1951. Plans are being made to initiate control programs in North Carolina, Tennessee, and Kentucky. An extensive experimental program was initiated in southern Missouri in 1952; this should serve as a guide for future control activities both there and in Arkansas.

Future Activities

The Federal Government and various States expect to conduct and to cooperate in making surveys for oak wilt in the summer of 1953. The success of attempts to arrest the spread of oak wilt are dependent upon a knowledge of the location of diseased trees. It will be necessary to continue surveys to locate trees not found earlier or becoming diseased after the first known infections have been eradicated.

It is exceedingly doubtful if all oak-wilted trees can be found in any State. The disease is sometimes obscure on white oaks, and the forested areas are too extensive to permit a careful examination of individual trees. By using airplanes for locating wilted trees, large areas can be examined at a reasonable cost ahd most of the diseased trees located. Surveys of this type should be adequate for the suppression program outlined above.

The cooperation of all interested in the problem is solicited in determining the distribution of the disease. We urge that oak wilt infections found in new areas be reported to Federal or State agencies conducting surveys. Specimens collected from trees suspected of having oak wilt should be sent to your State Pathologist or State Agricultural Experiment Station.

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FURTHER INCREASE OF DUTCH ELM DISEASE IN ILLINOIS

Richard J. Campana

Since Dutch elm disease was first found in Illinois in 1950, [1] it has increased in both 1951[2]

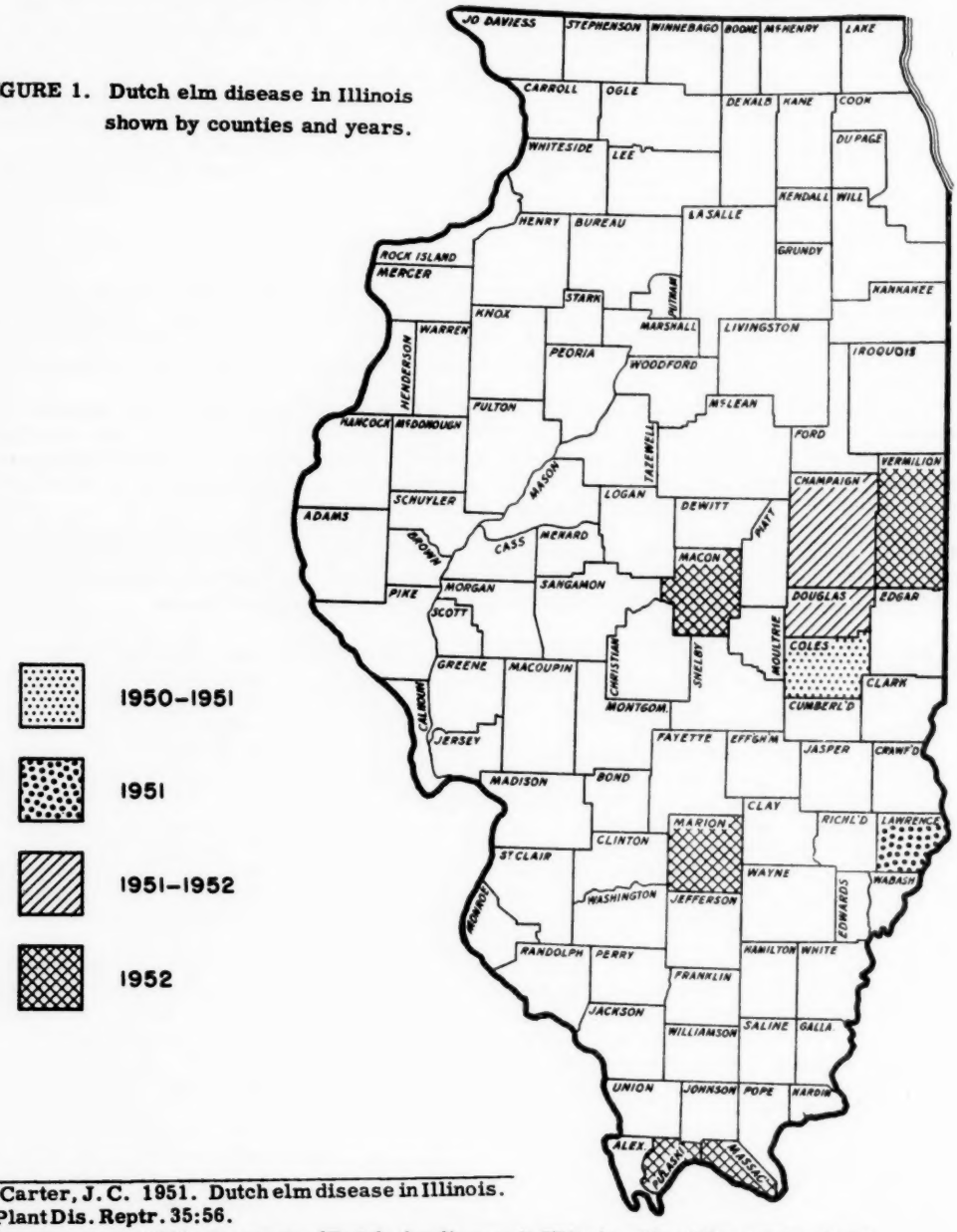

FIGURE 1. Dutch elm disease in Illinois shown by counties and years.

[1] Carter, J. C. 1951. Dutch elm disease in Illinois. Plant Dis. Reptr. 35:56.

[2] Carter, J. C. 1952. Increase of Dutch elm disease in Illinois. Plant Dis. Reptr. 36:24.

and 1952. One infected tree was found in Coles County in 1950 and 11 more infected trees were found in four counties, all near the eastern border of Illinois, in 1951.

During 1952, 24 infected trees were found in seven counties (Fig. 1). These infections were widely distributed from Hoopeston in Vermilion County on the north to Mounds in Pulaski County and Metropolis in Massac County at the southern extremity of the State and extended west to Argenta and Oreana in Macon County and Vernon in Marion County. The diseased trees were distributed among the counties as follows: 16 in Champaign, 2 in Douglas, 2 in Macon, and 1 each in Marion, Massac, Pulaski, and Vermilion. The numbers of infected elms found so far in the State are listed in Table 1 by county and year.

Table 1. Number of trees infected with Dutch elm disease in Illinois, by county and year.

County	Year		
	1950	1951	1952
Champaign	0	4	16
Coles	1	1	0
Douglas	0	5	2
Lawrence	0	1	0
Macon	0	0	2
Marion	0	0	1
Massac	0	0	1
Pulaski	0	0	1
Vermilion	0	0	1
Total	1	11	24

In Coles and Lawrence counties, which had one case each of the disease in 1951, no diseased trees were found in 1952. The finding of so large a number of diseased trees in Champaign County can be attributed to intensive and systematic scouting in connection with elm phloem necrosis in the Champaign-Urbana area. As no systematic search or intensive survey was made for new cases of Dutch elm disease in 1952, isolations of the causal fungus outside of Champaign County were the result of random observations of diseased trees. No explanation for the widespread occurrence of the newly found cases of the disease in the State can be given, other than that the disease is spreading and becoming more abundant. Possibly many more diseased trees would have been found with intensive and systematic scouting. With the large amount of elmwood resulting from trees killed by elm phloem necrosis, it is expected that an increasingly abundant reservoir of inoculum of Ceratostomella ulmi will be available for increased spread and distribution of the disease by an increased population of bark beetles in future years.

SECTION OF APPLIED BOTANY AND PLANT PATHOLOGY, ILLINOIS STATE NATURAL HISTORY SURVEY, URBANA, ILLINOIS

RESULTS OF FUNGICIDE TESTS FOR CONTROL OF SYCAMORE ANTHRACNOSE IN 1952

P. F. Hoffman

Ten fungicides were tested on sycamore (Platanus occidentalis) in 1952 for control of anthracnose (Gnomonia veneta). Applications were made on April 8, 22, and May 6, the first as a delayed dormant application, the others corresponding to the broken bud and young leaf stages of seasonal development of the host.

In 1952, in contrast with the preceding three years 1949, 1950, and 1951 when there was very little sycamore anthracnose in Illinois, the disease was prevalent throughout the State. Also, in 1952 anthracnose infection, in contrast with its usual tendency to appear as early leaf blight, became apparent for the most part at the time when the leaves had expanded fully. Twig and stem lesions were abundant; several 5- and 6-foot trees in our experimental planting were killed by cankers that developed on their trunks.

Because of lack of infection in previous years, steps were taken to increase the incidence of anthracnose in the disease nursery by the mist-blown application of conidia of Gnomonia. Favorable weather, however, stimulated natural infection to such an extent that results of the artificial inoculations were masked.

Disease readings were taken on June 4. Only leaves showing actual infection were counted; therefore, the dead leaves on shoots that were killed by girdling cankers lower down on the stem were disregarded. Materials used and the degree of disease control obtained are shown in Table 1.

Table 1. Fungicides tested on sycamore and control of anthracnose (Gnomonia veneta) obtained in 1952; five trees per treatment. Experiments in Illinois.

Sprays used		Percent of leaves blighted	Index of control
Fungicide	Amount per 100 gallons		
Puratized Agricultural Spray	1 pt.	6	82
Tag 331	1/2 pt.	9	73
Dithane Z-78	2 lb.	15	55
Fermate	2 lb.	18	45
Vancide 51 plus sticker	2 lb.	19	42
Phygon	1 lb.	19	42
Experimental Fungicide 640[a]	2 lb.	25	24
Zerlate	2 lb.	26	21
Experimental Fungicide 466-C[b]	1/2 lb.	32	3
Untreated		33	
Vancide 51-ZW	2 lb.	35	-6

[a] Product of Carbide and Carbon Chemicals Division, Union Carbide and Carbon Corporation.

[b] Product of Mathieson Chemical Corporation.

Two organic mercury compounds, Puratized Agricultural Spray and Tag 331, were the most effective fungicides used against anthracnose. Leaf infection on trees treated with Puratized Agricultural Spray was estimated at 6 percent, on trees treated with Tag 331 at 9 percent, in contrast with that on untreated trees, which was estimated at 33 percent. Defoliation of trees that received the best treatments was negligible; defoliation of the untreated trees was considerable. The effectiveness of Puratized Agricultural Spray in controlling anthracnose was consistent with the results obtained by Carter (1) and Dimond and Potts (2). In a two year test, Schuldt (3) found Bordeaux mixture superior to Puratized Agricultural Spray

Table 2. Control of sycamore anthracnose obtained with different spray schedules in 1952; each schedule used on five trees with each fungicide. Experiments in Illinois.

Schedule[a]	Puratized Agricultural Spray		Fermate	
	Percent of leaves blighted	Index of control	Percent of leaves blighted	Index of control
Single sprays				
1	30	21	39	-5
2	10	74	19	49
3	30	21	33	11
Combinations				
1, 2	4	89	18	51
1, 2, 3	8	79	24	35
1, 3	28	26	30	19
2, 3	9	76	27	27
Untreated	38		37	

[a] 1 - delayed dormant; 2 - broken bud; 3 - young leaf.

and three other fungicides.

Eight spray schedules were tested to determine the minimum number and best combination of spray applications necessary for adequate control of sycamore anthracnose. Table 2 lists the schedules, materials used, and degree of disease control obtained.

Spray number 2, applied at the broken bud stage, appeared to be of greatest significance. In the absence of this application disease control fell off sharply. If the disease can be consistently controlled by a single, properly timed application, spraying for the control of sycamore anthracnose should become more widespread.

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SECTION OF APPLIED BOTANY AND PLANT PATHOLOGY, ILLINOIS STATE NATURAL HISTORY SURVEY, URBANA, ILLINOIS

RESULTS OF FUNGICIDE TESTS FOR CONTROL OF LEAF DISEASES OF BLACK WALNUT, CATALPA, AND AMERICAN ELM IN 1951 AND 1952

J. C. Carter and P. F. Hoffman

In 1951, six fungicides were tested on black walnut and four on catalpa and, in 1952, 13 fungicides were tested on American elm for control of leaf diseases. In 1951, applications were made on June 13 and July 3; in 1952, on May 29 and June 20. Tables 1, 2, and 3 show the materials tested and the degrees of disease control obtained on walnut, catalpa, and elm. Leaf spot of walnut (Marssonina juglandis) and leaf spot of catalpa (Alternaria catalpae) appeared during early August, 1951, and data on control of each disease were recorded in early September. Black leaf-spot of elm (Gnomonia ulmea) appeared during early July, 1952, and disease readings were made in August. Leaf spot was less on sprayed trees than on unsprayed trees.

Table 1. Fungicides tested on walnut and control of leaf spot (Marssonina juglandis) obtained in 1951. Experiments in Illinois.

Sprays used				
Fungicide	Amount per 100 gallons	Average number of disease spots per leaflet	Reduction in leaf spot number, as percent	Estimated defoliation, as percent
Puratized Agricultural Spray	1 pt.	1.1	94.6	3
Vancide 51	4 pt.	6.4	68.5	5
Orthocide 406	2 lb.	9.6	52.7	10
Fermate	2 lb.	11.4	43.8	5
Experimental Fungicide 640[a]	2 lb.	12.4	38.9	3
Experimental Fungicide 466-C[b]	3 oz.	15.1	25.6	15
Untreated		20.3		60

[a] Product of Carbide and Carbon Chemicals Division, Union Carbide and Carbon Corporation.
[b] Product of Mathieson Chemical Corporation.

Table 2. Fungicides tested on catalpa and control of leaf spot (Alternaria catalpae) obtained in 1951. Experiments in Illinois.

Sprays used			
Fungicide	Amount per 100 gallons	Average number of disease spots per leaf	Reduction in leaf spot number, as percent
Experimental Fungicide 640[a]	2 lb.	16.1	66.7
Experimental Fungicide 466-C[b]	3 oz.	17.6	63.6
Vancide 51	4 pt.	25.9	46.4
Experimental Fungicide 723[b]	1 lb.	38.1	21.1
Untreated		48.3	

[a] Product of Carbide and Carbon Chemicals Division, Union Carbide and Carbon Corporation.
[b] Product of Mathieson Chemical Corporation.

Table 3. Fungicides tested on American elm and control of black leaf spot (Gnomonia ulmea) obtained in 1952. Experiments in Illinois.

Sprays used			
Fungicide	Amount per 100 gallons	Percent of leaf surface infected per tree	Reduction in leaf surface infected, as percent
Tag 331	1/2 pt.	0.0	100.0
Phygon	1 lb.	6.1	86.5
Puratized Agricultural Spray	1 pt.	6.6	85.4
Vancide 51 & sticker	2 lb.	7.7	83.0
Parzate	2 lb.	9.4	79.2
Orthocide 406	2 lb.	13.6	69.9
Dithane Z-78	2 lb.	16.1	64.4
Experimental Fungicide 466[a]	1/2 lb.	16.8	62.8
Vancide 51 ZW	2 lb.	18.7	58.6
Fermate	2 lb.	25.0	44.7
Experimental Fungicide 5400[b]	2 lb.	30.5	32.5
Zerlate	2 lb.	32.7	27.6
Experimental Fungicide 640[b]	2 lb.	36.1	20.1
Untreated		45.2	

[a] Product of Mathieson Chemical Corporation.
[b] Product of Carbide and Carbon Chemicals Division, Union Carbide and Carbon Corporation.

Walnut trees sprayed with Puratized Agricultural Spray had the least amount of leaf spot. They had 94.6 percent less leaf spot than the unsprayed trees or an average of 1.1 spots per leaflet. The unsprayed trees had an average of 20.3 spots per leaflet. Pronounced defoliation of the unsprayed trees was estimated at 60 percent. Defoliation on sprayed trees varied from an estimated 3 percent for those treated with Puratized Agricultural Spray to 15 percent for those treated with Mathieson Chemical Corporation Experimental Fungicide 466-C. None of the materials caused foliage burn, but Experimental Fungicide 466-C caused abundant leaf roll. Fermate, which appeared to have been taken into the tissues of the leaflets, caused dark brown discoloration of tissues between the veins on the under side of some leaflets on one tree. Insufficient infection in 1952 prevented the estimation of fungicidal effectiveness.

Catalpa trees sprayed with Carbide and Carbon Chemicals Division Experimental Fungicide 640 and Mathieson Chemical Corporation Experimental Fungicide 466-C had the least amount of leaf spot. Those sprayed with Experimental Fungicide 640 had 66.7 percent less leaf spot and those sprayed with Experimental Fungicide 466-C 63.6 percent less than the unsprayed trees. The unsprayed trees had an average of 48.3 spots per leaf. None of the materials caused foliage burn or premature defoliation.

American elms sprayed with Tag 331 had no leaf spot. Unsprayed trees had an average of 45.2 percent of the foliage surface affected with leaf spot. Phygon, Puratized Agricultural Spray, Vancide 51, and Parzate were next in order of effectiveness. Experimental Fungicide 5400 and the two organic mercuries, Tag 331 and Puratized Agricultural Spray, caused a small amount of browning of foliage.

SECTION OF APPLIED BOTANY AND PLANT PATHOLOGY, ILLINOIS STATE NATURAL HISTORY SURVEY, URBANA, ILLINOIS

FOURTEENTH ANNUAL NEW YORK - NEW ENGLAND FRUIT SPRAY SPECIALISTS CONFERENCE, NOVEMBER 5 TO 6, 1952

Summary of Disease Incidence in 1952[a]

Compiled by C. J. Gilgut

CROP Disease	Distribution and amount of disease									
									New York	
	Maine	New Hampshire	Vermont	Massachusetts	Rhode Island	Connecticut	Hudson Valley	Champlain Valley
APPLE								
Scab (Venturia inaequalis)	G 1	G 3	G 1	G 2-3	G 3	G 2-3	G 2	G 1
Fire blight (Erwinia amylovora)	L 0	0	L 0	L 0		0	0	L 0
Black rot (Physalospora obtusa)	L 0	G 1	0	G 1	G 1	G 0	0	L 1
Cedar rust (Gymnosporangium juniperi-virginianae)		L 1	0	L 0	G 1	G 0	L 1	
Brooks fruit spot (Mycosphaerella pomi)	L 0	0	0			G 0	L 1	
Winter injury	L 1		L 1					
Quince rust (Gymnosporangium clavipes)	L 0						L 1	L 1
Sulfur and sun scald injury			G 1	G 2	G 3		G 3	G 1-2
Hail				L 1-2		L 2		
Botrytis rot							G 1	
Mercury injury				G 1-3			G 3	
PEACH								
Brown rot (Monilinia fructicola)		G 1		G 1	G 1	G 1-2		
Leaf curl (Taphrina deformans)		G 2		G 0-1	G 1	G 1-2		
Valsa canker (Valsa sp.)		0		L 0	G 2	L 0		
Winter injury		0		L 0-1		L 0		
X-disease (Virus, Carpophthora lacerans)		L 1		L 1		L 0	G 1-2	
Copper injury		L 1						
Scab (Cladosporium carpophilum)		L 1		L 1	G 1	L 0		
Bacterial spot (Xanthomonas pruni)		0		L 0	G 1	L 0		
Fusicoccum canker(Fusicoccum persicae)				L 2				
PEAR								
Fire blight (Erwinia amylovora)	L 0	L 3		L 0		L 0	0	L 1
Leaf blight (Fabraea maculata)	L 0	0			G 1		L 1	
Scab (Venturia pyrina)	L 0	L 1		L 0	G 1	L 0	L 1	L 3
Sooty blotch (Gloeodes pomigena)	L 0	L 1		L 0	G 1	L 0	L 1	
Undetermined injury	L 0							

[a]KEY TO SYMBOLS:

Distribution -- G, general; L, local

Amount -- 0, negligible; 1, slight (less than 5 percent) 2, moderate (5 to 20 percent); 3, serious (20 percent and up)

CROP Disease	Distribution and amount of disease								
								New York	
	Maine	New Hampshire	Vermont	Massachusetts	Rhode Island	Connecticut	Hudson Valley	Champlain Valley
CHERRY									
Brown rot (Monilinia fructicola)		L 3							
Leaf spot (Coccomyces hiemalis)		G 3							
Ring spot (virus)		0							
Yellows (leaf drop) (virus)		L 1							
Black knot (Dibotryon morbosum)		L 1							
PLUM AND PRUNE									
Brown rot (Monilinia fructicola)		L 3		G 1		G 1-2			
Black knot (Dibotryon morbosum)		L 2		L 1		G 1			
Undetermined injury						L 0			
Leaf spot (Coccomyces prunophorae)		L 2		G 1		L 0			
GRAPE									
Black rot (Guignardia bidwellii)		G 3		G 1	G 1-2	G 1			
Downy mildew (Plasmopara viticola)		0		L 0		G 1			
Powdery mildew (Uncinula necator)		0		L 0	L 0	G 1			
2, 4-D injury		L 3		L 3					
RED RASPBERRY									
Anthracnose (Elsinoe veneta)	G 0	G 1		L 1-2	G 2	L 0			
Botrytis mold-rot	G 0	G 2		G 0	G 1	G 0			
Mosaic (Virus, Marmor rubi)	G 2	G 2		G 1-2		G 0-1			
Spur blight (Didymella applanata)	G 0	G 3		G 1-2	G 1	G 0			
Wilt (Verticillium albo-atrum)	L 0	0							
STRAWBERRY									
Ripe rot (Botrytis)	G 0	0		G 1	G 2	L 0			
Leaf spot (Mycosphaerella fragariae)	G 1	G 1		L 1	G 2	G 2-3			
Leaf scorch (Diplocarpon earliana)		L 1				G 2-3			
Leaf blight (Dendrophoma obscurans)		0			G 2	G 2-3			
Dwarf (Aphelenchoides fragariae)		0		L 0		?			
Red stele (Phytophthora fragariae)	G 1	L 3		L 0		G 0			
Black root (root rot complex)	G 1	L 1		G 2-3		G 0			
BLUEBERRY									
Mummy berry (Botrytis) [Monilinia vaccinii-corymbosi]		L 1		L 0	G 1	L 0			
Stunt (Virus)		0				L 1			
Powdery mildew (Microsphaera alni)	L 0	0				L 0			
Leaf rust (Pucciniastrum myrtilli)	G 1	L 1			L 0	L 0			
Phomopsis twig blight (Phomopsis sp.)		0			L 0	?			

UNIVERSITY OF MASSACHUSETTS, AMHERST

ESTIMATED LOSSES IN YIELDS DUE TO DISEASES OF MAJOR CROPS IN COLORADO FOR 1952

Compiled by members of the Department of Botany and Plant Pathology,
Colorado Agricultural and Mechanical College, Fort Collins.
(Transmitted by W. D. Thomas, Jr.)

CROP Disease	Percent loss for State
WHEAT	
Physiogenic (winter drying, etc.)	30
Root rots (Helminthosporium, Pythium, and Fusarium)	8
Leaf rust (Puccinia rubigo-vera var. tritici)	T
Steam rust (Puccinia graminis var. tritici)	0
Stinking smut (Tilletia spp.)	T
Snow mold (Typhula sp.)	T
OATS	
Physiogenic (high temperatures with high wind)	25
Covered smut (Ustilago avenae)	0
Loose smut (U. kolleri)	T
BARLEY	
Covered smut (Ustilago hordei)	T
Loose smut (U. nuda)	T
Root rot (various)	T
Stem rust (Puccinia graminis)	0
Septoria head blight (S. passerinii)	T + (increase)
Yellow dwarf (virus)	T
CORN	
Seed rot and seedling blight (complex)	1
GRASS	
Seed rot and seedling blight (various)	8
Snow mold (Typhula sp.)	T
Ergot (Claviceps purpurea)	T
ALFALFA	
Bacterial wilt (Corynebacterium insidiosum)	8
Downy mildew (Peronospora trifoliorum)	T
Fusarium crown rot	T
Leaf spots (various)	T
Mildews [= ?]	T
Seed rot and seedling blights (various)	5.5
Winter drying	5
SUGAR BEET	
Blackroot (complex)	1
Curly top (virus)	T
Virus yellows	T
Leaf spot (Cercospora beticola)	T
Fusarium yellows (F. conglutinans var. betae)	1
Rhizoctonia (R. solani)	3
POTATO	
Bacterial ring rot (Corynebacterium sepedonicum)	1
Blackleg (Erwinia phytophthora)	3
Early blight (Alternaria solani)	7

CROP Disease	Percent loss for State
POTATO (continued)	
Fusarium wilts (Fusarium spp.)	4
Late blight (Phytophthora infestans)	1
Leafroll (virus)	2
Mosaic and other viruses except leafroll	2
Psyllid yellows (insect toxin)	0
Rhizoctonia (R. solani)	2
Scab (Streptomyces scabies)	5
Leak (Pythium sp.). Observed in San Luis Valley at harvest; not over 2 percent loss for area	1
TOMATO	
Bacterial canker (Corynebacterium michiganense)	T
Blossom-end rot (non-parasitic)	1
Mosaic and other viruses (except curly top)	2
Early blight (Alternaria solani)	0
Fusarium wilt (F. oxysporum f. lycopersici)	12
Phytophthora leaf and fruit blight (P. infestans)	0
Purple top or psyllid yellows (insect toxin)	0
Septoria leaf spot (S. lycopersici)	T
Verticillium wilt (V. albo-atrum)	1
Curly top (western yellow blight) (virus)	1
BEAN	
Bacterial blights (Xanthomonas phaseoli, Pseudomonas phaseolicola)	5
Bacterial wilt (Corynebacterium flaccumfaciens)	1
Curly top (virus)	T
Mosaic (virus)	1
Root rot (Fusarium and Rhizoctonia)	5
Red node (virus)	1
Rust (Uromyces phaseoli)	T
Seed rot and seedling blight	2
White mold (Sclerotinia sclerotiorum)	T
PEAS	
Ascochyta (A. pisi, A. pinodella, Mycosphaerella pinodes)	0
Bacterial blight (Pseudomonas pisi)	T
Fusarium wilt, and root rot complex	2
ONION	
Bacterial soft rot of bulbs (Erwinia carotovora)	T
Downy mildew (Peronospora destructor)	0
Fusarium bulb rot (Fusarium oxysporum f. cepae)	20
Pink root (Pyrenochaeta terrestris) and purple top (Alternaria porri)	T
Smut (Urocystis cepulae)	T
CANTALOUPE	
Anthracnose (Colletotrichum lagenarium)	0
Bacterial wilt (Erwinia tracheiphila)	0
Fusarium wilt (F. oxysporum f. melonis), and Fusarium fruit rot (F. spp.)	20
Leaf blight (Alternaria cucumerina)	T
CUCUMBER	
Angular leafspot (Pseudomonas lachrymans)	5
Anthracnose (Colletotrichum lagenarium)	0
Bacterial wilt (Erwinia tracheiphila)	0

CROP Disease	Percent loss for State
CUCUMBER (continued)	
Fusarium wilt (Fusarium sp.)	7
Mildew (powdery, Erysiphe cichoracearum)	0
Mosaic (virus)	5
LETTUCE	
Seed rot and seedling blight (various)	T
Downy mildew (Bremia lactucae)	T
Fusarium yellows (F. sp.)	T
CARROT	
Soft rot in packaging [?Erwinia carotovora]	1
Damping-off of seedlings (various)	T
CELERY	
Early blight (Cercospora apii)	T
Late blight (Septoria spp.)	2
Pink rot (Sclerotinia sclerotiorum)	T
Yellows (virus)	5
CABBAGE AND CAULIFLOWER	
Blackleg (Phoma lingam)	0
Yellows (Fusarium oxysporum f. conglutinans)	1
APPLE	
Fire blight (Erwinia amylovora)	T
Powdery mildew (Podosphaera leucotricha)	T
PEAR	
Fire blight (Erwinia amylovora)	8
PEACH	
Coryneum blight (C. carpophilum)	T
Powdery mildew (Sphaerotheca pannosa)	T
Cytospora canker (Cytospora sp.)	T
Mosaic (peach mosaic virus)	T
Western X-disease (virus)	1
APRICOT	
Coryneum blight (C. carpophilum)	T
CHERRY	
Little cherry or Western X-disease (virus)	2
Winter injury to sour cherry	10
Winter injury to sweet cherry	2
STRAWBERRY	
Leaf spot (Mycosphaerella fragariae)	T
Red stele (Phytophthora fragariae) and root rots (various)	25
CARNATION	
Virus diseases (mosaic, streak, and yellows)	20
Fusarium wilt and root and stem rot (F. spp.)	18
Fusarium wilt (F. oxysporum f. dianthi)	2
Rust (Uromyces caryophyllinus)	10

COLORADO AGRICULTURAL AND MECHANICAL COLLEGE, FORT COLLINS

NEW RECORDS AND UNUSUAL OBSERVATIONS

REDUCTION OF SMOG INJURY BY RUST INFECTION

By C. E. Yarwood

Smog[1] injury is becoming increasingly prevalent in the San Francisco Bay area of California, though not so severe as in southern California. It has been especially noticeable on greenhouse-grown beans, tobacco, and petunia in Berkeley. On beans it starts as a bronzing of the lower leaf surface, and eventually the leaf drops off by abscission at the pulvinus. During three years it has been noticed that on four occasions beans infected with rust (Uromyces phaseoli) showed less smog injury than healthy beans. Smog injury was inhibited in zones on the leaves extending throughout the rusted areas and for about 2 to 5 mm beyond the rust infection.

DEPARTMENT OF PLANT PATHOLOGY, UNIVERSITY OF CALIFORNIA, BERKELEY, CALIFORNIA

[1] Middleton, John T., J. B. Kendrick, Jr., and H. H. Schwalm. 1950. Smog in the south coastal area. Calif. Agr. 4(11):7-10.

SOUTHERN BLIGHT ON APPLE NURSERY STOCK IN INDIANA

By J. R. Shay

A serious outbreak of southern blight caused by Sclerotium rolfsii occurred in 1952 in one-year apple nursery stock in a commercial nursery near Indianapolis, Ind. First notice was taken of dying trees by the nurseryman in late July following five weeks of unusually hot and wet weather. Weekly temperatures during the five-week period, June 3 through July 8, averaged from 3° to 11° F. above normal. Rainfall during the same period totalled 7.61 inches, occurring largely as heavy flash rains of almost 2 inches each. Dying of trees continued until late September. Approximately 10 percent of the trees were destroyed in a stand of about 20,000.

As noted by Cooley in Maryland nurseries (Phytopathology 26: 1081, 1936), the infections were scattered in the nursery rows with healthy trees interspersed among those wilted or dead. The roots of dying trees were killed to the soil line, with the stem remaining green for some time after all leaves were browned. Dead leaves tended to persist on the twigs of trees after the main root had been girdled by the fungus. White mycelia and sclerotia in all stages of development were found in abundance on or near infected roots.

Southern blight has not previously been observed in this nursery. However, Gardner reported the organism on larkspur in a location near Indianapolis in 1920. The disease can be considered to be of rare occurrence in Indiana.

DEPARTMENT OF BOTANY AND PLANT PATHOLOGY, PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION, LAFAYETTE, INDIANA

PLANT DISEASES NEW TO PERU

By C. Bazán de Segura

During the last several months the following disease-producing organisms not previously known to occur in Peru were named from material studied at "El Centro Nacional de Investigacion y Experimentacion Agricola La Molina".

ALLIUM CEPA, Onion:
Heterosporium allii, on leaves. Huánuco.
CARICA PAPAYA, Papaw:
Phytophthora cinnamomi, attacking roots and causing wilt of plants. Chanchamayo.
CASSIA sp.:
Ravenelia portoricensis, rust on the leaves. Bagua (Amazonas)[1]
CITRUS AURANTIUM, Sour Orange:
Macrophomina phaseoli (Sclerotium bataticola), attacking roots of seedlings and plants. Chiclayo and Huaral.
EUCALYPTUS sp.:
Hendersonia sp., producing spots on leaves. Contumaza.
HELIANTHUS ANNUUS, Sunflower:
Albugo tragopogonis, on leaves. Contumaza.

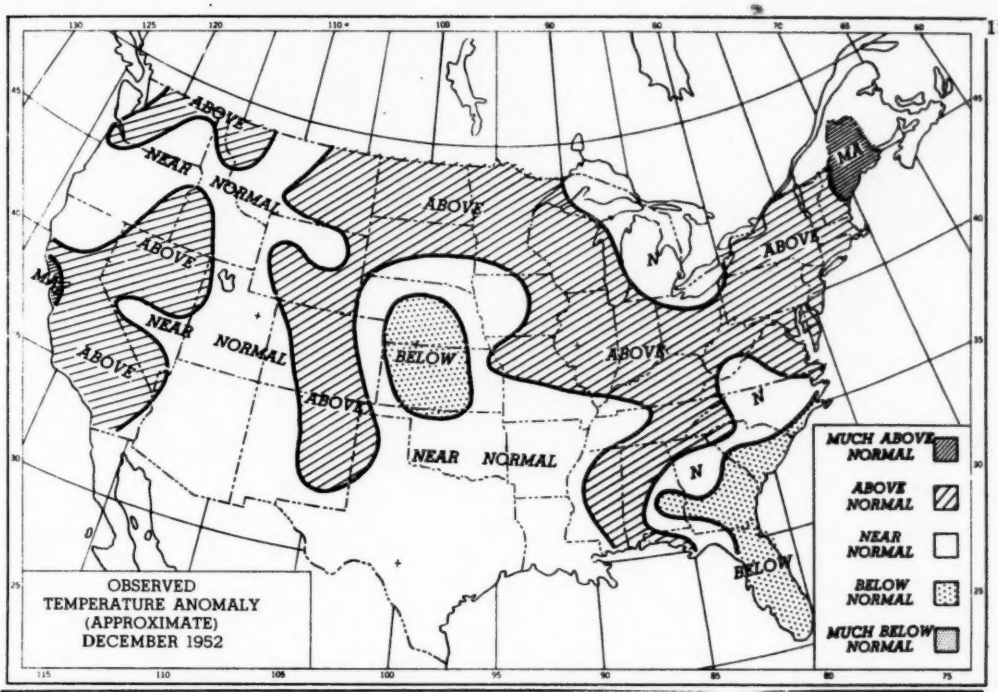
JUGLANS REGIA, Common Walnut Tree:
Septoria sp., on leaves. Contumaza.
LAGERSTROEMIA INDICA, Crape Myrtle:
Oidium sp., powdery mildew on leaves. Lima
OCOTEA ARCHITECTORUM:
Phytophthora cinnamomi, on roots. Chanchamayo.
PASSIFLORA LIGULARIS, Sweet Granadilla:
Botrytis cinerea, attacking leaves. Lima
PERSEA GRATISSIMA, Avocado:
Cephaleuros virescens, on leaves. Cuzco.
Phytophthora cactorum, attacking roots of plants. Lima
SOLANUM ANDIGENUM, Potato:
Sclerotium rolfsii, causing stem rot of plants. Lima

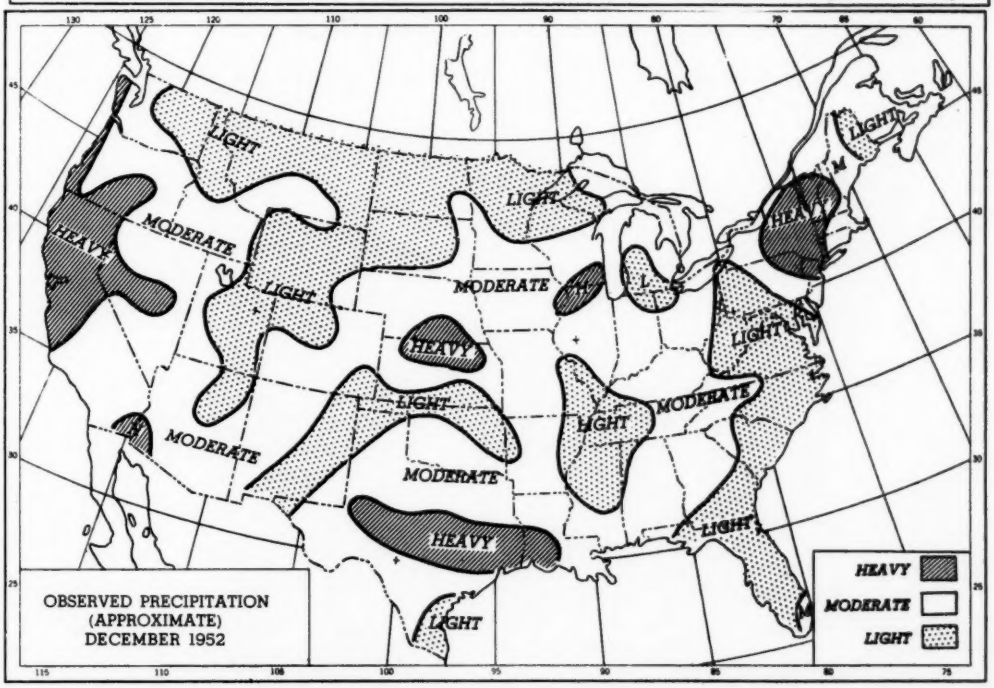
CENTRO NACIONAL DE INVESTIGACION Y EXPERIMENTACION AGRICOLA DE LA MOLINA, LIMA, PERU

[1]Determined by Dr. Geo. B. Cummins, Purdue Univ.

A CORRECTION

The name of Dr. M. B. Moore, plant pathologist at University Farm, St. Paul, Minnesota, was inadvertently omitted from the list of cooperators mentioned on page 428, Plant Disease Reporter, Vol. 36, No. 11, Nov. 15, 1952.





The terms used in the accompanying maps, which define the ranges of temperature and precipitation, are numerical class limits. These are based on a statistical analysis of past records through which is determined the normal frequency of occurrence of temperatures and precipitation at various times of the year for different locations. For temperature the classes above, below, and near normal are so defined that they each normally occur one-fourth of the time; much above and much below normal, one-eighth of the time. Precipitation is depicted in terms of light, moderate, and heavy, each class normally occurring one-third of the time and thereby having equal probability of occurrence. These maps graphically represent only the general trends and give the country's weather picture at a glance. For quantitative studies, where monthly mean temperatures and actual precipitation records are needed for a given time and place, other publications of the Weather Bureau should be consulted. P. R. M.